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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 7565, 7714–7716, 7973, 8645, and 8984.

7440 (BNWL–531–4) INDUCED RADIONUCLIDES IN ASTRONAUTS. Final Activity Report to the NASA Ames Research Center, June 15, 1967–September 1, 1968. Brodzinski, R. L.; Wogman, N. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1, 1968. Contract AT(45-1)-1830. 56p. Dep. CFSTI.

Activity-dose energy relationships for ^{7}Be, ^{13}N, ^{22}Na, and ^{24}Na activities induced in unshielded muscle tissue and tissue equivalent phantoms by bombardment of protons up to 580 MeV were measured, and the relationship between radiation dose and induced activity for any given proton bombarding energy is defined. The determination of the radiation dose received by an astronaut from cosmic radiation of unknown energy by measuring the concentration of the radioactive isotopes induced in his body is discussed. Measurements to define the excretion pattern of induced radionuclides from proton irradiated patients, and studies of the cosmic-ray dose to high altitude pilots were also continued. (67 references). (auth)

7441 (CEA-R–3531) CONTINUOUS ANALYTICAL CONTROL OF THE STREAMING WATERS IN A URANIUM TREATMENT PLANT AND OF VARIOUS CHEMICAL PRODUCTS USING AUTOMATIC DISCHARGE VALVES. Archimbaud, Michele; Simeon, Claude (Commissariat a l'Energie Atomique, Pierrelatte (France)). Oct. 1968. 24p. (In French). Dep.

A method for controlling the streaming waters produced by the Pierrelatte Centre is described. It is based on continuous analysis, with simultaneous recording of the species liable to be found accidentally in the corresponding hydrological circuits (chlorides, fluorides, chromium VI, uranium). An alarm set off at pre-determined thresholds leads to an automatic cutting off of the discharge valves; the outward flow of the waters is thus interrupted. The results indicate the various applications which can be found for this water control method, and give an idea of the economics involved. (auth)

7442 (CONF-681020–(Vol.2), pp 667-74) INSTRUMENTAL DETERMINATION OF RARE EARTH ELEMENTS BY ACTIVATION ANALYSIS. Fleishman, D. M.; Lukens, H. R. (Gulf General Atomic, Inc., San Diego, Calif.).

In determination of rare earths by neutron activation, the NaI(Tl) detector was replaced by a Ge(Li) detector in order to determine whether the latter, which has better energy resolution but poorer detection efficiency than the former, could be used to advantage. The analysis was simpler and more complete with the Ge(Li) detector, but the 15 cc Ge(Li) detector was not as efficient as the 3-in. × 3-in. NaI(Tl) detector. (M.C.G.)

7443 (K–1757) MEASURING FISSION PRODUCT ACTIVITY IN URANIUM CONTAINING ^{232}U DAUGHTERS. Flynn, A. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 12, 1968. Contract W-7405-eng-26. 9p. Dep. CFSTI.

The method specified by the USAEC for measuring fission product activity in uranium hexafluoride was adapted to material produced from spent nuclear fuel containing ^{232}U and its daughters; a convenient gamma spectrometer correction for the daughter activity is used. The uranium and thorium are extracted into tributyl phosphate, leaving the fission products and the ^{232}U daughters (except ^{228}Th) in the aqueous phase. The total gamma activity of the aqueous phase is measured in a high-pressure ionization chamber as specified and corrected for the ^{232}U daughter activity, using a correlation between the gamma activity of ^{208}Tl (a ^{232}U daughter) and the total gamma activity of the ^{232}U daughters. To establish this correlation, the uranium is extracted from ^{232}U standards the remaining ^{208}Tl is measured by gamma spectrometry and the total gamma activity is measured with the high-pressure ionization chamber. A similar correction is made for the beta activity of the ^{232}U daughters, using a correlation established between the ^{208}Tl gamma activity and the total beta activity of the ^{232}U daughters. (auth)

7444 (KAPL–3322) LWB/LSBR DEVELOPMENT PROGRAM: HIGH CROSS-SECTION IMPURITIES IN REACTOR CORE MATERIALS. Wisnyi, L. G. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1967. Contract W-31-109-eng-52. 28p. Dep. CFSTI.

The level of parasitic impurities of 27 undesirable elements was determined in the four principal reactor core materials: Zircaloy-4, ZrO_2, UO_2, and ThO_2. The nuclear effect of these impurities was evaluated from a reactor physics standpoint and correlated to the "conversion ratio" and "fissile inventory ratio" of a typical breeder-type core. The results indicate that some improvement can be achieved by removing the hafnium from Zircaloy-4 and ZrO_2, and also by removing the rare earths, gadolinium in particular, from the ThO_2. This improvement could extend the core life by about 2000 hr depending upon the specific core design. Of a secondary nature is the removal of alkali and alkaline earth contaminants from ZrO_2 because of the associated lithium content. No detrimental impurities were found in UO_2. Present analytical procedures are adequate for determining the impurity level whose control is paramount in producing a relatively clean breeding core. (auth)

7445 (UCRL–50522) THE DIRECT DETERMINATION OF FLUORIDE IN MOLYBDENUM, RHENIUM, AND TUNGSTEN. Raby, Bruce A. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 9, 1968. 16p. Dep. CFSTI.

A procedure was developed for determination of fluoride in molybdenum, rhenium, tungsten, and rhenium–tungsten alloys. The sample is fused with sodium nitrate and sodium hydroxide in a platinum crucible and the melt is dissolved in water. A Dowex 1-X8 anion exchange column and 0.5 M sodium chloride elutriant separate the fluoride from the metal. The fluoride is determined in the eluate with a fluoride ion activity electrode. An alternate procedure, used when only molybdenum and/or tungsten are present, is to measure the pF of the melt solution without a prior separation of the metal. These procedures may be used to determine 1 to 1000 μg of fluoride in a gram sample, with a relative standard deviation of about ±2%. (auth)

7446 FLUORIMETRIC DETERMINATION OF HAFNIUM IN THE PRESENCE OF ZIRCONIUM. Brookes, A.; Townshend, A. (Univ. of Birmingham, Eng.). Chem. Commun., No. 24, 1600 (Dec. 18, 1968).

The method described is based on the use of quercetin, and is stated to provide the first sensitive fluorimetric method for the determination of Hf in the presence of an appreciable excess of Zr. It was found that in 9M perchloric acid containing 2.5% ethanol Zr does not form a fluorescent complex with quercetin, whereas Hf gives an intensely fluorescent species. When ~1.5×10^{-5} M reagent was used, 1 to 20 μg Hf gave a linear calibration graph, unaffected by at least five times as much Zr. (UK)

7447 ACTIVATION ANALYSIS OF TRACE-ELEMENTS IN HUMAN NAILS. 2. ZINC, COPPER, AND MANGANESE. Shinbori, Yoshio (Musashi Inst. of Tech., Japan). Sangyo Igaku, 10: 289-92(May 1968). (In Japanese).

Trace elements of zinc, copper, and manganese in human nails were measured by (n,γ) reactions using the TRIGA-II reactor. Zinc was determined by Zn-quinaldate precipitation method, the chemical yield being 70 to 75%. Copper was determined by Cu-salicylaldoxime precipitation process, the yield being constant at a value of more than 75 to 77%. Manganese was determined by an oxidation method, the yield being constant at a value over 70%. The 0.85 MeV γ rays and 2.6 MeV β rays were measured. (NSA of Japan)

7448 LUMINESCENT DETERMINATION OF EUROPIUM AND TERBIUM BY MEANS OF A FILTER FLUOROMETER. Melent'eva, E. V.; Tishchenko, M. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Kiev). pp 207-10 of Sovremennyye Metody Khimicheskogo i Spektral'nogo Analiza Materialov. Sbornik Obzorov i Metodik. Moscow, Izdatel'stvo Metallurgiya, 1967. (In Russian).

The possibility of using a fluorometer with filters instead of the scarce ISP-51 spectrograph with an FEP-1 photoelectric attachment in determinations of Eu and Tb was demonstrated. In the determination of Eu, the reaction with thenoyltrifluoroacetone and phenanthroline in benzene solution was used, and in the analysis for Tb, 4-sulfophenyl-3-methyl-5-pyrazolone was employed. The sensitivity of the determination of Eu was 0.008% Eu_2O_3 in all the rare earths studied and 0.02% Eu_2O_3 in the presence of samarium, and that of Tb, 0.003 to 0.007% Tb_4O_7. (ATD)

7449 CORGAM. Eckhoff, N. D. (Kansas State Univ., Manhattan). Nucl. Sci. Eng., 35: 157(Jan. 1969).

The computer program CORGAM, for coding an algorithm to allow unfolding of complex γ-ray spectra collected in neutron activation analysis procedure, is briefly described. The program is written in FORTRAN IV for the IBM 360/50 computer. (J.W.R.)

7450 DETERMINATION OF ALUMINUM IN MOLYBDENUM BY NEUTRON ACTIVATION. Fedoroff, Michel (CNRS, Vitry, France). Compt. Rend., Ser. C, 267: 1227-9(Nov. 4, 1968). (In French).

The radioactivity from molybdenum prevents the determination of aluminum without chemical separation. A rapid separation is carried out compatible with the short period of decay of ^{28}Al, by fixing it on a cationic resin which does not retain the radioisotopes arising from the molybdenum. The measurement of the radioactivity of the resin permits the determination. (tr-auth)

7451 MANGANESE TOXICATION IN THE HUMAN BODY DETERMINED BY ACTIVATION ANALYSIS. Anong Nilubol, M. L.; Chayawatanangkur, Kantikar; Kritalugsana, Sompool (Thai Atomic Energy Commission, Bangkok, Siriraj Hospital, Bangkok). J. Nucl. Med., 9: 178-80(May 1968).

An increase of the concentration of manganese in body fluid from persons exposed to large amounts of manganese ore dust was detected. Neutron activation analysis was used to detect very low levels of manganese in body fluids of normal and exposed persons. The destructive method must be used because of large amounts of interfering ^{24}Na, but the separation method is rapid and simple. From these results normal manganese levels (in mg/100 ml) appear to vary between 0.002 and 0.008 for blood, 0.0001 and 0.0008 for urine and 0.0004 and 0.0012 for cerebrospinal fluid. Definite increases in the amount of manganese present in the body fluids of persons suffering from manganese poisoning were noted. The results indicate that the use of neutron activation analysis as a diagnostic tool for this condition is clearly feasible. (auth)

7452 DETERMINATION OF THE DEGREE OF DE-EMANATION FOR A ^{228}Th SOLUTION. Heyder, J.; Kaul, A. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Atompraxis, 14: 484-5(Nov.-Dec. 1968). (In German).

For a Th-228 solution the degree of de-emanation was determined by γ-spectrometry measuring the variation of the Pb-212-activity of the solution. For this reason the solution was de-emanated by air over a period of 60 hours at constant air-flow velocities. The degree of the de-emanation proved to be dependent on the air-flow velocity, and both the form and dimensions of the de-emanation flask. For an Erlenmeyer flask of 200 cm^3 volume and 100 cm^3 of a Th-228 standard solution the degree of the de-emanation increased from 52 to 82% for air-flow velocities between 2 and 10 l/min. (auth)

7453 DETERMINATION OF THE PRECISE COMPOSITION OF THE TRIPLE SODIUM URANYL ACETATES OF MAGNESIUM, ZINC, AND NICKEL, AND SOME OBSERVATIONS ON THE USE OF THE FIRST TWO COMPOUNDS FOR THE DETERMINATION OF SODIUM. Monk, R. G. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Talanta, 15: 1259-65(Nov. 1968).

Three triple sodium uranyl acetates $NaM(UO_2)_3(CH_3COO)_9 \cdot nH_2O$ in which the bivalent metals M were magnesium, zinc, and nickel were precipitated and the air-dried compounds analyzed for uranium by a highly precise method. Despite contrary claims it was established that the compounds are precise hexahydrates, the maximum deviation of n from 6 in any one analysis being 0.1. The precipitation of sodium as the magnesium or zinc compound gives results which depend on the excess of the reagents, and positive errors can be obtained. It is also concluded that, contrary to the usual belief, the magnesium compound is rather less soluble than the zinc compound and is therefore somewhat more sensitive for sodium determination. (auth) (UK)

7454 SEPARATION OF CESIUM FROM RADIOACTIVE SOLUTIONS BY ALUMOSILICATE ION EXCHANGERS. Lambrino, Vl.; Furnica, Gh. Rev. Chim. (Bucharest), 19: 464-7 (Aug. 1968). (In Rumanian).

Studies carried out at various locations revealed that atmosphere, water, and vegetation contain appreciable amounts of ^{134}Cs. This radionuclide accumulates in living organisms, replacing potassium. A method was developed for determining ^{134}Cs in liquid media, using ion exchangers fabricated from natural aluminosilicates obtained from four locations in Rumania. X-ray diffraction studies revealed that all of the bentonites used were Ca montmorillonites. The chemical composition, ion-exchange capacity and the time dependence of inhibiting and absorption capacity with respect to benzene of the samples were determined. The decontaminating efficiency of the material was tested on 3- to 4-mm-diameter and 5-mm-long granules, measuring the activity of $^{134}CsCl$ with a scintillation counter. Several processes, ion exchange, absorption and adsorption, were involved in the retention of ^{134}Cs. From the viewpoint of ion exchange, samples calcined at 400 to 600°C were found to be most efficient. Montmorillonite-type aluminosilicates are suited for separating radioisotopes. (TTT)

7455 STEREOCHEMISTRY OF METALLOCENES. PART 20. DETERMINATION OF THE OPTICAL PURITY OF METHYLFERROCENE-α-CARBOXYLIC ACID (PART 40 ON FERROCENE DERIVATIVES). Reich-Rohrwig, P.; Schloegl, K. (Univ., Vienna). Monatsh, Chem., 99: 1752-63(Sept.-Oct. 1968). (In German).

The optical purity of methylferrocene-α-carboxylic acid (1) was determined by two methods: isotope dilution, employing ($^2H_1$-methyl)ferrocene-α-carboxylic acid, and a procedure based on the evaluation of the relative intensities of diastereotopic protons in the NMR spectra of the α-phenethylamides of 1 having different rotations. By both methods corresponding results were obtained: optically pure 1 has an $[\alpha]_D$ of 55.6 ± 1.0°C and 54 ± 3°C, respectively. The value for 1 as found by optical resolution is 51.5 ± 0.8°C and 53 ± 2°C, respectively. Hence, the rotations of all 90 ferrocene derivatives previously correlated with 1 by unambiguous chemical methods have, if at all, to be corrected only slightly. (auth)

7456 SOME APPLICATIONS OF ACTIVATION TO THE ANALYSIS OF EARTHS, MINERALS, AND ROCKS. Bondy, Charles; Ricq, Jean-Claude (Atome Industriel, Grenoble, France). Bull. Soc. Chim. Fr., No. 10, 4277-9(Oct. 1968). (In French).

Activation analysis of earths, minerals, and rocks for manganese, sodium, aluminum, europium, and lanthanum by activation with thermal neutrons; and for iron, aluminum, silicon, and phosphorus by activation with fast neutrons is reported. In general, in contrast with organic substances, these substances are dissolved after irradiation. The elements to be determined and those which interfere are separated by paper chromatography or by ion exchange. Applications are given for thorium, gold, tantalum, scandium, hafnium, cobalt, iron, cesium, and zinc. A radiochemical procedure is reported for measuring the exchange capacity of alkaline earths. (auth)

7457 SULPHURIC ACID–PERCHLORIC ACID DECOMPOSITION FOR DETERMINING ^{137}Cs AND ^{90}Sr IN FOOD ASH. Randow, F. (Univ., Rostock, Ger.). Atompraxis, 14: 494(Nov.-Dec. 1968). (In German).

An ash-decomposition procedure for determining ^{137}Cs and ^{90}Sr in foodstuffs is described. The method is used to prepare large amounts of sample material in one step for radiochemical analysis of the two nuclides. (auth)

7458 NON-DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF GOLD IN BIOLOGICAL MATERIAL BASED ON THE ANALYSIS OF THE DISINTEGRATION CURVE. Prouza, Z.

(Veterinary Research Center, Prague); Rakovic, M. Cas. Lek. Cesk., 107: 1053-6(Aug. 23, 1968). (In Czech).

Experimental work performed in the nuclear reactor at Rez is described. The samples were protected by cadmium foil. The disintegration curve was obtained by integral assessment on a scintillation counter. Beta radiation was eliminated by means of copper filters. (JPRS)

7459 DETERMINATION OF MICROAMOUNTS OF NIOBIUM IN IRON AND STEEL BY THE SPECTROPHOTOMETRIC METHOD. Sakaki, Takashi (Japan Special Steel Co., Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 913-18(1968). (In Japanese).

An experiment was carried out to establish a simple and accurate method for the determination of microamounts of niobium in iron and steel. The niobium was coprecipitated as pentaoxide with tungstic acid by the hydrolysis method with sodium sulfite and tannic acid in hydrochloric and perchloric acids to which 5 ml of sodium tungstate solution (1 ml = 1 mgW) was added as coprecipitating reagent and was separated from other elements. By means of this separation method, the microamounts of niobium can be separated accurately from iron and others. The separated niobium was determined by the spectrophotometric method with xylenol orange. In this spectrophotometric method, there is no significant effect even in the event 0.1 mg of aluminum, 1 mg each of antimony, bismuth, iron, manganese, tin, and zirconium, 0.02 mg of chromium, 0.5 mg each of cobalt, copper, nickel, phosphorus, and tantalum, 20 mg of molybdenum, 5 mg of titanium, 0.2 mg of vanadium, and 50 mg of tungsten are contained in the separate sample solution. As a result of the experiment, a method was established in which 0.005 to 0.05% of niobium in iron and steel can precisely be measured without difficulty. The niobium contents in synthetic and actual samples were measured by this method with satisfactory results. (auth)

7460 PREPARATION OF ZIRCALOY STANDARD SAMPLES FOR SPECTROCHEMICAL ANALYSIS. Kashu, Seiichiro; Nagase, Michio; Hayashi, Chikara; Nakajima, Tokunosuke; Takashima, Kyoichiro (Japan Vacuum Engineering Co., Ltd., Yokohama, Japan). Nippon Kinzoku Gakkaishi, 32: 919-25(1968). (In Japanese).

The preparation of Zircaloy standard samples for spectrochemical analysis by using a 120 kW electron-beam skull furnace is described. Major elements (Sn, Fe, Ni, and Cr) and impurity elements, such as Al, Cu, Ti, Si, Co, B, and Hf, were observed before and after the skull casting. Three major elements (Sn, Fe, and Ni) in Zircaloy can be controlled to within ±10% of the respective predicted preset level, provided each content in the skull being previously controlled to within ±50% of a predetermined value. Chromium showed a low and scattered yield. Composition analysis of major elements in the upper, middle, and lower parts of an ingot showed less than 4% deviation in Sn, 8% in Fe and Ni, and 11.1% in Cr from the average contents in the ingot. Impurity elements of B, Ti, Si, and Al in Zircaloy can be controlled to within ±15% of the preset level. Yields of Cu and Co are less than 20% and widely scattered results are obtained even if the 120 kW rotated electron beam is used. Chemical analysis of impurity elements in the upper, middle, and lower parts of the ingot showed less than 5.2% deviation in Ti and less than 10% in B, Si, Co, Cu and Al from the average contents of the respective elements. In skull melting of the alloy, there is an active zone near the surface of the skull which reacts with the molten pool. For control of the Al or Ti content in Zircaloy the surface layer of the skull up to 5 mm in depth is estimated to be reactive. (auth)

7461 INCREASING THE SENSITIVITY OF THE DETERMINATION OF EUROPIUM AND SAMARIUM ADMIXTURES IN PREPARATIONS OF RARE EARTH ELEMENTS. Melent'eva, E. V.; Kononenko, L. I.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Kiev). pp 202-6 of Sovremennyye Metody Khimicheskogo i Spektral'nogo Analiza Materialov. Sbornik Obzorov i Metodik. Moscow, Izdatel'stvo Metallurgiya, 1967. (In Russian).

A highly sensitive fluorescent method was developed for determining Eu and Sm in rare earth salts. The reaction is carried out in a water–alcohol medium, and precipitates a ternary complex compound with phenanthroline and thenoyltrifluoroacetone which in the presence of Eu or Sm fluoresces strongly in UV light. The fluorescence spectra were recorded with an ISP-51 spectrograph with an FEP-1 photoelectric attachment. The sensitivity of the determination depends on the base element. In the presence of La, Gd, Tb, Yb, Lu, and Y, the sensitivity for Eu is 2 to 8×10^{-4}%, and for Sm, 1.25 to 5×10^{-3}%. The method was verified by analyzing oxides isolated from minerals. (ATD)

7462 BIBLIOGRAPHY OF PAPER AND THIN-LAYER CHROMATOGRAPHY 1961–1965 AND SURVEY OF APPLICATIONS. Macek, Karel; Hais, Ivo M.; Kopecky, Jan; Gasparic, Jiri (eds.). J. Chromatogr., Suppl., 1-1041(1968).

References (9618) are given to books and journals published from 1961 through 1965. An author index and a list of chromatographed substances are included. (P.C.H.)

7463 SOLUTION OF BLANK PROBLEMS IN 14-MeV NEUTRON ACTIVATION ANALYSIS FOR TRACE OXYGEN. Nargolwalla, S. S.; Przybylowicz, E. P.; Sudduth, J. E.; Birkhead, S. L. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 41: 168-70(Jan. 1969).

The technique used in a study of blank problems in 14-MeV neutron activation analysis for trace oxygen gives consideration to the sample-in-container geometry and any attenuation effects which may arise during irradiation and counting. The study contributes to the state of the art in the following ways: determination of the attenuation of the activity from the container by samples of different diameters; definition of a geometrical model which quantitatively expresses the observed attenuation by the samples; and design of a flow-through container for solid samples which reduces the capsule blank contribution and eliminates the need to encapsulate samples in a nitrogen atmosphere provided the propelling gas in the pneumatic system is dry nitrogen. (D.H.M.)

7464 ANALYSIS OF RARE EARTH MATERIALS BY CATHODOLUMINESCENCE SPECTRA EXCITED IN AN ELECTRON MICROPROBE. Kniseley, R. N.; Laabs, Francis C.; Fassel, Velmer A. (Ames Lab., Iowa). Anal. Chem., 41: 50-3(Jan. 1969).

The optical fluorescence (cathodoluminescence) emitted by some materials when they are irradiated by a sharply focused beam of electrons provides an exceptionally powerful means of detecting and determining impurities at very low absolute concentration levels. The focused beam provided by electron microprobe instruments is ideally suited for these applications, because the beam size may be reduced to areas less than 1 μ^2. Thus, spectroscopic analysis of the emitted radiation can provide information on the spatial distribution of impurities as well as the overall composition of the sample. Detection limits as low as 50 ppB were obtained for rare earth elements in ideal host materials such as La_2O_3 and Y_2O_3. Considering the volume sampled by the electron beam, this corresponds to an absolute detection limit of $\sim 10^{-16}$ gram, a level seldom obtained by other analytical techniques. Several problems involved in quantitative analysis are considered and methods for circumventing these are discussed. (auth)

7465 DETERMINATION BY NEUTRON ACTIVATION ANALYSIS OF THE BURN-UP INDICATOR ^{148}Nd IN IRRADIATED URANIUM DIOXIDE–PLUTONIUM DIOXIDE. Monsecour, M. R.; Demildt, A. C. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Anal. Chem., 41: 27-31(Jan. 1969).

A radiochemical method was developed for the isolation of Nd from irradiated UO_2-PuO_2 fuel elements and measurement of ^{148}Nd by neutron activation analysis. The method is based on separation by reversed phase chromatography, with di(2-ethylhexyl)ester orthophosphoric acid (D2EHPA) as the stationary phase, and anion exchange on Dowex 1-X4 columns mixed with PbO_2. The chemical yield, after the subsequent steps, is determined by adding ^{147}Nd tracer at the start of the separation procedure. The ^{148}Nd(n,γ)^{149}Nd neutron activation reaction carried out in the BR 2 reactor is used for the radiochemical determination. (auth)

7466 THE RADIOASSAY OF ^{45}Ca AND ^{89}Sr FROM BIOLOGICAL SYSTEMS BY LIQUID SCINTILLATION COUNTING. Hardcastle, James Edward. Tucson, Ariz., Univ. of Arizona, 1967. 93p. Thesis.

The development of methods for the radioassay of ^{45}Ca, ^{89}Sr, and ^{45}Ca–^{89}Sr double-labeled samples by liquid scintillation spectrometry is reported. The samples, obtained from such natural sources as plants and soils, were first digested and converted to the chloride form. Then the chloride salt of the isotopes was dissolved in a di-n-propyl phosphate-toluene-fluor scintillation mixture, and counted in a liquid scintillation spectrometer. A method is described for calculating the individual isotope activities from a ^{45}Ca–^{89}Sr double-labeled sample. The factors affecting this radioassay technique were studied. Counting efficiencies of 85% for ^{45}Ca and 95% for ^{89}Sr were obtained using this procedure. The procedure is simple, fairly rapid, and capable of high precision. (Disser. Abstr.)

7467 COMPREHENSIVE ABBREVIATED EXPRESSION FOR DYNAMIC RANGES IN ATOMIC-ABSORPTION FLAME PHOTOMETRY. Ramirez-Munoz, Juan; Brace, Robert O. (Beckman Instruments, Inc., Fullerton, Calif.). Appl. Spectrosc., 22: 736-41(Nov.-Dec. 1968).

Different abbreviated expressions for concentration dynamic ranges are proposed and discussed. These expressions are also intended to give information on percentual sensitivity (related to slope of analytical calibration curves) and noise level. Use of logarithmic terms permits calculation of total dynamic range ratios when using instruments that allow wide variation of instrumental sensitivity. (auth)

7468 SPECTROCHEMICAL DETERMINATION OF RARE EARTHS IN CALCIUM FLUORIDE. Weisberger, Sol (Bayside Lab., N. Y.). Appl. Spectrosc., 22: 719-21 (Nov.-Dec. 1968).

A spectrochemical method was developed for the determination of type 4f rare earths (except lanthanum and cerium) in amounts usually employed in the activation of calcium fluoride. The method converts the fluoride sample to a common matrix, calcium sulfate, thereby eliminating the possibility of errors in the subsequent arcing of the sample due to previous physical and chemical treatment. Since the "burn" is made in air and recorded in the so-called "metallurgical region," no elaborate apparatus is needed for analysis. (auth)

7469 ELEMENTAL ANALYSIS OF CRACKING CATALYSTS BY X-RAY FLUORESCENCE. Rayburn, Kenneth A. (W. R. Grace and Co., Clarksville, Md.). Appl. Spectrosc., 22: 726-9 (Nov.-Dec. 1968).

X-ray fluorescence analysis was applied to the routine determination of Al, Si, K, Ca, Ti, Fe, Ni, V, and light rare earths (e.g., La, Ce, Pr, Nd, and Sm) found in petroleum refining catalysts. Two different fusion techniques, using lithium tetraborate, are utilized to cover the elements desired over the necessary concentration ranges. A straight fusion technique can be used for rare earths, Fe, Ni, V, and Al and Ti in used catalysts. A heavy absorber fusion technique is necessary to determine Si and Al in fresh catalysts, clays, or other materials with wide matrix variations. (auth)

7470 ULTRA-TRACE DETERMINATION OF RARE EARTHS IN GALLIUM ARSENIDE. Wang, M. S. (Monsanto Co., St. Louis). Appl. Spectrosc., 22: 761-4 (Nov.-Dec. 1968).

Determination of rare earth elements in gallium arsenide by a dc arc was studied. An argon and oxygen atmosphere was carefully selected to enhance the selective volatilization of rare earths, which comes at the very end of arcing in this matrix. The controlled atmosphere also contributed to suppression of the CN band and allowed the use of this region. A commercially available standard was used to mix with the matrix for preparation of synthetic standards. The recovery means were within 30% of the amount added and relative coefficients of variations were within 16%. The range of determinations, below the 1 ppM levels, is reported. (auth)

7471 DIRECT METHOD FOR DETERMINATION OF MICROQUANTITIES OF MOLYBDENUM, IRON, AND COPPER IN MILK XANTHINE OXIDASE FRACTIONS BY ATOMIC ABSORPTION SPECTROSCOPY. Roussos, G. G.; Morrow, B. H. (Veterans Administration Hospital, Kansas City, Mo. Kansas Univ. School of Medicine, Kansas City, Kan.). Appl. Spectrosc., 22: 769-72 (Nov.-Dec. 1968).

Microgram and submicrogram quantities of molybdenum, iron, and copper in bovine milk and intestinal xanthine oxidase fractions were determined by atomic absorption spectroscopy using the standard addition method. Dialysis fluids consisting of 0.1 to 10 mM potassium phosphate buffer, pH 7.4, containing 0.01 to 1 mM ethylenediaminetetraacetate served as blanks and diluents for both samples and standards. The sensitivities of the method for iron, molybdenum, and copper were 0.02 to 0.05, 0.01 to 0.02, and 0.01 to 0.02 (μg/ml)/1% absorption, respectively. Coefficients of variation of 8.2, 6.6, and 4.2% were obtained with samples containing 0.11, 0.056, and 0.021 μg/ml of iron, molybdenum, and copper, respectively. Occasional interferences encountered with either concentrated or partially purified fractions could be completely eliminated by direct dilution of the sample. Known quantities of all three metals added to various enzyme preparations were quantitatively recoverable. Dry ashing prior to analysis had no effect on the analytical results. (auth)

7472 DETERMINATION OF ^{240}Pu IN PLUTONIUM BY OPTICAL EMISSION SPECTROSCOPY. Limpert, John C. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Appl. Spectrosc., 22: 777-81 (Nov.-Dec. 1968).

Isotopic analysis for ^{240}Pu in plutonium by optical emission spectroscopy was studied. The choice of analytical and internal standard lines, wavelength measurement, conditions for sample preparation, and excitation in a sustained ac arc are discussed. Data are presented concerning the determination of ^{240}Pu over a range of 3 to 17% with a relative precision of the order of ±1% at the 95% confidence level, in addition to optical emission vs mass spectrographic data. (auth)

7473 LABELLING OF THE AIR BY MEANS OF THE REACTION $^{10}B(n,\alpha)^{7}Li$. Gottschalk, Juergen (Technische Univ., Hanover). Atomkernenergie, 14: 47-50 (Jan.-Feb. 1969). (In German).

Air is labeled with methylboric acid to study aeration. The decrease in concentration of boron in air samples taken at different time intervals after labeling permits calculation of the dilution by aeration. The concentration of boron in the air samples is determined in proportional counters using the reaction $^{10}B(n,\alpha)^{7}Li$. The sensitivity and the mean error of the determination of boron are examined. It is possible to detect 3×10^{-3} torr of a compound containing one boron atom, if the sample of the air has a volume of 200 cm^3 and the thermal neutron flux amounts to 10^5 [cm^{-2} s^{-1}]. The mean error of the measurement is ±6.4%. (auth)

7474 USE OF 630-keV DEUTERONS FOR THE SIMULTANEOUS DETERMINATION OF CARBON AND OXYGEN ON SURFACES OF METALLIC SAMPLES. Barrandon, Jean-Noel; Debrun, Jean-Luc; Cuypers, Marc; Quaglia, Lino; Robaye, Guy (CNRS, Val-de-Marne, France. Univ., Liege). Compt. Rend. Ser. C, 267: 1306-8 (Nov. 13, 1968). (In French).

The nuclear reactions $^{16}O(D,p)^{17}O^*$, $^{12}C(D,p)^{13}C$, and $^{12}C(D,n)^{13}N^*$ have made it possible to determine the quantities of carbon and oxygen present on the surface of metallic samples. The results show quantitatively in what proportion oxygen and carbon adsorbed on the surface can become a cause of error in the determination of very small amounts of these elements by combustion and reduction melting. (tr-auth)

7475 [POLAROGRAPHIC] DETERMINATION OF NIOBIUM IN ZIRCONIUM–NIOBIUM ALLOYS. Stepanova, I. K.; Sinyakova, S. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zavod. Lab., 33: 931-3 (1967). (In Russian).

The sample (0.1 g) containing ≈1% Nb is dissolved in 2 ml of H_2SO_4 containing 0.5 g of $(NH_4)_2SO_4$, the cooled solution is diluted to 25 ml with 7.5M HCl, and an aliquot (2 to 3 ml) is diluted to 100 ml with 7.5M HCl. After passage of N through the solution for 5 to 10 min a vector polarogram is recorded over the range 0 to −0.8 V vs the mercury pool. The graph of peak height vs concentration of Nb is rectilinear with 0.5 to 10 μg of Nb per ml. Zirconium does not give a wave in 7.5M-HCl and its content can be 250 times that of the Nb; Mo is tolerated in 500-fold amount and W in 3-fold amount, but Fe interferes. (Anal. Abstr.)

7476 RAPID POLAROGRAPHIC DETERMINATION OF NIOBIUM IN ORES AND CONCENTRATES. Volkova, G. A.; Martynova, L. T.; Sochevanov, V. G. (All-Union Scientific Research Inst. of Mineral Raw Materials, Moscow). Zavod. Lab., 33: 933-5 (1967). (In Russian).

The sample (0.1 to 1 g) is fused with 3 to 5 g of NaOH, the melt is dissolved in 200 ml of H_2O, and HCl (20 to 30 ml more than the amount required to neutralize the solution to Congo red) is added. (If F^- are present the Nb and other metals are isolated by precipitation with aq NH_3.) The solution is boiled for 10 to 20 min, cooled slightly, and treated with 100 ml of 3% tannin solution, then boiled for 1 hr and set aside overnight. The precipitate containing Nb and Ta is collected, washed with 2% HCl, and ignited, and the residue is heated to incipient fumes with 3 ml of HF and H_2SO_4 (1:1) (1 ml for a 1-g sample containing 0.1 to 1% of Nb_2O_5 to 4 ml for a 0.1-g sample containing 10% of Nb_2O_5). The cooled solution is poured into a hot solution containing 9% of EDTA and 10% of KOH (10 ml for a 1-g sample to 40 ml for a 0.1-g sample), then diluted 2 to 2.5 times, and heated. The pH is adjusted to 3.0 to 3.5, 1 drop of H_2SO_4 (1:1) is added, and the solution is boiled for 2 to 3 min., then cooled and treated with an acetate buffer solution (20 g of Na acetate, 30 ml of H_2O and 50 ml of anhydrous acetic acid) (1 ml per 50 ml of final solution) and finally diluted to 50 ml (for a 1-g sample) to 200 ml (for a 0.1-g sample). A vector polarogram for Nb is recorded within the range −0.4 to −0.8 V vs the S.C.E. Iron, Ti, U, Cu, Zn, Sn, Ni, Co, Al, Mn, W, V, Zr and Th do not interfere, and the final solution can contain up to 30 μg of Ta per ml. Interference is caused by Mo, Pb, Sb, Bi and As. (Anal. Abstr.)

7477 ACTIVATION ANALYSIS OF ANTIMONY IN TIN BASED ON AN INTERNAL-MONITOR METHOD USING THERMAL NEUTRONS. Oka, Yoshinaga; Kato, Toyoaki; Tsai, Hui-tuh (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 41: 2427-30 (Oct. 1968).

An internal-monitor method proposed previously was applied to the determination of trace amounts of antimony in tin by activation with thermal neutrons. After the antimony activity was chemically separated from the irradiated sample, the γ-ray spectrum corresponding to a mixture of ^{124}Sb and ^{125}Sb formed by the β-decay of

^{125m},^{125}Sn was measured. Synthetic mixtures of antimony and tin with known weight ratios were prepared to check the accuracy of the method. Good proportionality was obtained between the ratios of the ^{124}Sb to ^{125}Sb activities and the ratios of the concentrations. This relationship was used to carry out the antimony analysis. The content of antimony in a sample of tin down to 0.2 ppM can be determined with a relative error of ±2%. (auth)

7478 A.C. POLAROGRAPHIC DETERMINATION OF LANTHANUM(III), NICKEL(II), CALCIUM(II), AND MAGNESIUM (II) BY USING DIETHYLENETRIAMINEPENTAACETIC ACID AS A TITRANT. Kodama, Mutsuo; Murata, Mitsuko (Ibaraki Univ., Mito, Japan). Bull. Chem. Soc. Jap., 41: 2405-10(Oct. 1968).

The ac polarographic determination of lanthanum(III), nickel(II), calcium(II), and magnesium(II) with diethylenetriaminepentaacetic acid was studied by using a dropping mercury electrode and a hanging mercury drop electrode as indicator electrodes. Lanthanum(III) and nickel(II) in an acetate buffer solution and calcium(II) and magnesium(II) in an ammonia buffer solution were titrated with diethylenetriaminepentaacetic acid in the concentration range from 5×10^{-5} to 1×10^{-3} M by measuring the height of the ac polarographic wave of diethylenetriaminepentaacetic acid after the end point. The effect of the presence of calcium(II) ions on the ac polarographic determination of lanthanum(III) in an acetate buffer solution of pH 4.0 was also examined and discussed thermodynamically. (auth)

7479 DIFFERENTIAL SPECTROPHOTOMETRIC DETERMINATION OF EUROPIUM IN YTTRIUM EUROPIUM VANADATE USING AN EXPANDED-SCALE ABSORPTION SLIDEWIRE. Lanning, Edward W. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Anal. Chem., 41: 182-3(Jan. 1969).

A differential spectrophotometric determination of Eu in yttrium europium vanadate is described using a slidewire for the Cary Model No. 14 which permits absorbances of from 0.0 to 0.2 to be read at ±0.0001. In order to reduce the background absorptions resulting from the dissolution of the samples, solutions were fumed with sulfuric acid, and in order to minimize inference the V was entirely reduced. Two methods used for the reduction were the addition of tartaric acid and the addition and subsequent removal of the excess SO_2 gas. The spectrophotometric results were compared with those obtained by other instrumental techniques. The duplicate results obtained by spectrophotometry indicate good precision, while the agreement with the other techniques indicates the overall validity of the proposed method. (D.H.M.)

7480 DETERMINATION OF TANTALUM AND ITS SEPARATION FROM NIOBIUM AND OTHER CLOSELY ASSOCIATED ELEMENTS USING TETRA-N-PENTYLAMMONIUM BROMIDE. Dosch, R. G. (Sandia Lab., Albuquerque, N. Mex.). Anal. Chem., 41: 193-5(Jan. 1969).

Tetra-n-pentylammonium bromide is proposed as an analytical reagent for the isolation and determination of Ta by gravimetric techniques. Tantalum is quantitatively precipitated as a white, easily filterable, tetra-n-pentylammonium tantalum hexafluoride (TPATF), which is subsequently fired, and the Ta weighed as Ta_2O_5. Interfering substances are limited to anions such as chromate, permanganate, perrhenate, tungstate, vanadate, and molybdate, which form nonvolatile tetra-n-pentylammonium compounds. Elements which form insoluble fluorides also interfere; however, these can be easily eliminated by filtration prior to precipitation of the Ta. Elements closely associated with Ta, those in Groups IV, V, and VI, were studied relative to their quantitative effect upon the precipitation of the TPATF. Quantitative separations were obtained in mixtures containing Ta to impurity ratios ranging from 10:1 to 1:10 with amounts of Ta ranging from approximately 10 to 150 mg. (D.H.M.)

7481 COMPLEXONOMETRIC ANALYSIS OF COMPLEX CARBIDE ALLOYS OF THE TRANSITION METALS OF THE IV-VI GROUPS. Kornilova, V. I.; Nazarchuk, T. N. (Inst. of the Material Problems, Kiev). Zh. Anal. Khim., 23: 1866-8(Dec. 1968). (In Russian).

A method has been developed for the complexometric determination of zirconium and hafnium in Zr-V-C and Hf-V-C alloys which is based on the direct titration of zirconium (hafnium) in the presence of xylenol orange and a peroxide complex of vanadium(V). A method has also been developed for the complexometric determination of zirconium, hafnium, and titanium in Zr-W-C, Hf-W-C, and Ti-W-C alloys. In this method tungsten is bounded in a citrate complex in the presence of hydrogen peroxide, then zirconium (hafnium) is determined by the titration with Complexone III in the presence of xylenol orange in a medium of 0.2 N H_2SO_4, titanium is determined by the titration of the Complexone III excess with a solution of bismuth nitrate at pH 3 with a mixed indicator (a mixture of xylenol orange and methylene blue solutions). (auth)

7482 PHOTOMETRIC DETERMINATION OF TUNGSTEN AND MOLYBDENUM AS THEIR HETEROPOLY COMPOUNDS. Reznik, B. E.; Ganzburg, G. M.; Mal'tseva, G. V. (Dnepropetrovsk State Univ., USSR). Zh. Anal. Khim., 23: 1848-51 (Dec. 1968). (In Russian).

Optimum conditions for the reduction of molybdenum-tungsten and tungsten-molybdenum complexes in solution have been studied spectrophotometrically. The molar ratios of molybdenum and tungsten in heteropoly compounds formed have been found. Methods are suggested for the photometric determination of molybdenum and tungsten when they are present together. (auth)

7483 USE OF POLYALCOHOLS FOR THE SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTH ELEMENTS OF THE YTTRIUM SUBGROUP. Poluektov, N. S.; Efryushina, N. P. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 23: 1802-6(Dec. 1968). (In Russian).

A method has been developed for determining microgram amounts of Y, Yb, and Lu in the presence of La, Ce, Pr, Nd, and Sm. The method is based on masking the color reaction of the elements of the cerium subgroup with methylthymol blue by means of sorbite. (auth)

7484 AMPEROMETRIC TITRATION OF NIOBIUM WITH CUPFERRON OR NEOCUPFERRON. Usatenko, Yu. I.; Tikhonova, A. P. (Dnepropetrovsk Chem.-Technol. Inst., USSR). Zavod. Lab., 33: 939-42(1967). (In Russian).

Titration of Nb with cupferron is satisfactory to 9M-H_2SO_4 in the presence of NaCl as coagulant; a precipitate forms up to 1.5M-acid but not in more acid solutions. Titration with neocupferron is satisfactory to 2M-HCl without a coagulant. In either instance titration is carried out with 0.02M-reagent at +1 V (graphite electrode) vs the S.C.E. Neocupferron is applicable over a wider concentration range (0.5 to 3.5 mg of Nb_2O_5 per 50 ml) than is cupferron (0.2 to 0.8 mg per 50 ml), and higher concentration of impurities (including Ta) can be tolerated. (Anal. Abstr.)

7485 MEDICINE, TRACE ELEMENTS, AND ATOMIC ABSORPTION SPECTROSCOPY. Christian, Gary D. (Univ. of Kentucky, Lexington). Anal. Chem., 41: 24A-40A(Jan. 1969).

Present applications of atomic absorption spectroscopy are discussed, specifically, use in determination of metals in the body. Topics considered include a brief discussion of the principles of atomic absorption spectroscopy; commercial instrumentation; methods of sample preparation; destruction of organic matter; preconcentration; purity of reagents; standardization; reporting results; and determination of metals in biological fluids. As more is understood about mineral metabolism, the routine monitoring of elements in the soil, plants, urine, blood, and other biological tissue may become important. Due to the combined sensitivity, specificity, and ease of sample preparation for many elements, as well as the relatively modest initial cost, atomic absorption spectroscopy will become one of the major methods of analysis. (D.H.M.)

7486 DETERMINATION OF NIOBIUM IN HIGH-ALLOY STEEL BY UV SPECTROPHOTMETRY. Doubek, L.; Komar, K. (Smeralovy Zav., Brno). Hutn. Listy, 22: 489-92(1967). (In Czech).

Dissolve the sample (0.8 to 3 g) in warm concentrated HCl (30 to 50 ml), oxidize with HNO_3 (5 to 10 ml), evaporate the acids and dry the residue. Dissolve the residue in concentrated HCl (10 to 20 ml) and heat the solution until clear; dilute with hot H_2O (40 ml), boil for 3 min and add a further 50 ml of hot H_2O. Filter, boil the solution briefly, and set it aside for 2 hr, or for 12 hr if <0.2% of Nb is present. Filter, wash the precipitate with dilute HCl until the washings are free from Fe, ignite the precipitate at 800°, and fuse the resulting oxides with K_2CO_3-Na_2CO_3 (2 g) for 10 min at 850° and 5 min at 900°. Extract the melt for 10 min with hot H_2O, boil, cool, and dilute with H_2O to 250 ml. Filter the solution, discarding the first 50 ml of filtrate; use the next 100 ml for the determination of Mo (if present) and measure the extinction of the remainder at 234.5 nm. Obtain the Nb content from a calibration graph. (Anal. Abstr.)

7487 DETERMINATION OF BARIUM AND STRONTIUM IN MAIZE MEAL AND BREAD FLOUR BY ATOMIC-ABSORPTION SPECTROMETRY AFTER SEPARATION BY ION-EXCHANGE CHROMATOGRAPHY. Strasheim, A.; Strelow, F. W. E.; Norval, E. (National Chemical Research Lab., Pretoria). J. S. Afr. Chem. Inst., 20: 25-31(1967).

Flour (100 g) is ashed, the ash is evaporated with HNO_3, and the residue is ignited at 800°, treated with HCl and filtered to remove SiO_2. The filter with the SiO_2 is ashed, and Si is volatilized as

SiF_4, then F^- is removed by evaporation with HCl; the residue is dissolved in 0.5N-HCl and added to the main filtrate. The pH is adjusted to 1.8 with aqueous NH_3, and the solution is transferred to a column of AG 50W-X8 resin (Cl^- form; 100 to 200 mesh) with 0.2N-NH_4Cl–0.05N-HCl buffer. The column is washed with 0.65N-ammonium lactate of pH 7 to remove Ca, P, and some other elements, then with N-HCl to remove NH_4^+; Ba plus Sr are then eluted with 3N-HNO_3, and the eluate is evaporated to dryness with HCl to destroy NO_3^-. With maize meal (300 g), the HCl solution of the ash is diluted to be 0.5N in acid and passed through a column of the resin (H^+ form); PO_4^{3-} are eluted with N-HCl, then Ba, Sr, Ca, Fe, and Mg are eluted with 3N-HNO_3. This eluate is evaporated to dryness, and the Ba plus Sr are separated as described for flour. The residue of $BaCl_2$ and $SrCl_2$ is dissolved in 0.5N-HCl (2 ml), and the solution is diluted to 10 ml with methanol for the atomic absorption determinations; for Sr, the solution is first diluted 1 in 5, keeping the HCl and methanol concentration constant. An acetylene–air flame is used, and measurements are made at 553.6 nm for Ba and 460.7 nm for Sr. The coefficient of variation was 10.5% for 12 determinations of Ba and 13.1% for 21 determinations of Sr. The recovery was 97 ± 5% for 1 to 2 ppm of Ba and 95 ± 9% for 0.5 to 1 ppm of Sr. (Anal. Abstr.)

7488 SPECTROCHEMICAL METHOD FOR THE DETERMINATION OF IMPURITIES IN HYDRIODIC ACID. Kuz'min, N. M. Zh. Anal. Khim., 22: 451-3(1967). (In Russian).

A method is described for the determination of 10^{-6} to 10^{-3}% of Al, V, Co, Mn, Cu, Mo, Ni, Pb, and Cr. The impurities are concentrated by evaporation of the acid with a graphite collector, or by extraction of the 8-hydroxyquinolinates of the elements into $CHCl_3$–isoamyl alcohol (4:1) at pH 5.5 to 6.0 and subsequent evaporation of the extract with a graphite collector. A 16-A ac arc is used for excitation of the spectra. The coefficient of variation was <20% for each element. (Anal. Abstr.)

7489 DECOMPOSITION OF CERTAIN ELECTRO-CONTACT MATERIALS, AND RAPID METHOD OF DETERMINING NICKEL THEREIN. Modylevskaya, K. D. (Inst. of Material Problems, Kiev). Zavod. Lab., 33: 948-9(1967). (In Russian).

Methods applicable to the decomposition of several different contact materials (mainly W-based) are listed. Nickel is determined by titration with EDTA in alloys containing large amounts of W, Ag, and Pd, or photometrically with dimethylglyoxime in tungsten and in tungsten alloys containing large amounts of Cu (which is masked with EDTA). (Anal. Abstr.)

7490 [COMPLEXOMETRIC] DETERMINATION OF ZIRCONIUM AND TITANIUM IN NIOBIUM-BASE ALLOYS. Bukhtiarov, V. E. Zavod. Lab., 33: 812-13(1967). (In Russian).

The sample (0.1 g) is dissolved in 5 ml of H_2SO_4 plus 2 g of K_2SO_4, the solution is evaporated to fumes, the residue is gently heated with 20 ml of 5% H_2O_2 solution and 10 ml of 6N-HCl, then the cooled solution is diluted to 100 ml. The solution is passed at 3 ml per min through a column of KU-2 (H^+ form), which is then washed with 1500 ml of 2% H_2O_2 in 0.24N-HCl at 5 ml per min and with 200 ml of H_2O. The Ti and Zr are eluted with 4N-HCl (8 × 100 ml) at 3 ml per min, the fractions being separately evaporated to small vol which are then combined. The solution is neutralized with aqueous NH_3 and heated with 15 ml of 6N-HCl, then diluted to 100 to 150 ml and boiled, and Zr is titrated with 0.05N-EDTA in the presence of xylenol orange. The titrated solution is treated with excess of EDTA solution, boiled, and made alkaline to methyl orange with aqueous NH_3, then cooled and made pale pink by the addition of a few drops of aqueous NH_3 (1:5). The unconsumed EDTA is titrated with Zn acetate solution to obtain the Ti content. (Anal. Abstr.)

7491 SPECTROCHEMICAL DETERMINATION OF IMPURITIES IN HIGH-PURITY IODINE. Polivanova, N. G.; Fratkin, Z. G. (Leningrad State Sci. Res. and Dev. Inst.). Zavod. Lab., 33: 970-1(1967). (In Russian).

The sample (10 g) is heated at 60° in a special apparatus to sublime the iodine, the residue is dissolved in 4 drops of HNO_3 (1:1) and the solution is transferred to the ends of two carbon electrodes previously treated with a solution of polystyrene in benzene. The spectrum of the dried residue is excited in an 8-A arc for the determination of Al, V, Fe, Au, Ca, Mg, Mn, Cu, As, Ni, Sn, Pb, Ag, Sb, Ti, Cr, and Zn. Indium is used as internal standard. The analytical line pairs used are listed. (Anal. Abstr.)

7492 X-RAY FLUORESCENCE TRACE ANALYSIS. DIRECT DETERMINATION OF ALUMINIUM, ANTIMONY, NIOBIUM, PHOSPHORUS, SILICON, TITANIUM, VANADIUM, TIN, AND ZIRCONIUM IN STEEL. de Laffolie, H. (Forschungsinstitut der Deutsche Edelstahlwerke A.-G., Krefeld, Ger.). Arch. Eisenhuettenw., 38: 535-40(1967). (In German).

The establishment of the calibration graphs and associated errors for these minor constituents (at levels for which the signal strength is comparable to the local background) is discussed. Because of the similarity of such calibration graphs, it is possible to determine several elements by utilizing reasonably adjacent fluorescence lines with only one background count and only one reference standard. This technique is illustrated by the determination of Sn, Sb, Nb, and Zr in steel, with Sn in aluminum as a reference standard; an automatic instrument is used. Limits of detection, for 1-min counts, range from 1.3 ppm for Ti to 70 ppm for Al. (Anal. Abstr.)

7493 SUBSTOICHIOMETRIC DETERMINATION OF MOLYBDENUM IN STEELS BY NEUTRON-ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Talanta, 16: 116-18(Jan. 1969).

A simple and rapid substoichiometric method for the determination of small amounts of molybdenum in steel by neutron activation analysis is based on the extraction of molybdenum α-benzoinoximate into chloroform. The sensitivity of the method is 0.2 μg and the relative standard deviation is 1%. Two activated samples can be processed and counted within 30 min. (auth) (UK)

7494 ACTIVATION ANALYSIS IN VIVO USING 5-MeV INCIDENT NEUTRONS. Newton, D. (Atomic Energy Research Establishment, Harwell, Eng.); Anderson, J.; Battye, C. K.; Osborn, S. B.; Tomlinson, R. W. S. Int. J. Appl. Radiat. Isotop., 20: 61-8(Jan. 1969).

Activation analysis using 5-MeV incident neutrons was considered as a method for estimating whole-body sodium, chlorine, and calcium in humans. Experiments with irradiated phantoms showed that adequate uniformity of thermal neutron activation could be achieved in most subjects, though when the incident neutron energy was reduced to 2.5 MeV serious non-uniformities arose. With 5 MeV incident neutrons, no difficulties are expected from the interfering activities induced by the fast flux when 14 MeV sources are employed. The method was applied successfully to the analysis in small animals. (auth) (UK)

7495 THE USE OF THRESHOLD ENERGIES IN 14-MeV NEUTRON ACTIVATION ANALYSIS. Oldham, G.; Darrall, K. G. (Loughborough Univ. of Tech., Eng.). Int. J. Appl. Radiat. Isotop., 20: 29-32(Jan. 1969).

The possibility of using double irradiation techniques with 14-MeV neutron generators for the determination of elements which give radioactive nuclei having the same principal γ-energies and similar half lives was demonstrated. The sensitivity of the method is critically dependent on neutron output, but improvements in generator design should give increasing scope to the use of this technique. (auth) (UK)

7496 SEMIPERMEABLE ION-EXCHANGE MEMBRANES AS A PRECONCENTRATION MATRIX FOR TRACE ANALYSIS BY ELECTROCHEMICAL AND NEUTRON ACTIVATION TECHNIQUES. Eisner, Uri; Mark, Harry B. Jr. (Univ. of Michigan, Ann Arbor). Talanta, 16: 27-35(Jna. 1969).

Ion exchange membranes were used in conjunction with neutron activation analysis and anodic stripping voltammetry for the determination of certain trace metal ions. The various parameters which govern the applicability, limitations, and sensitivity of the methods were investigated. A new membrane "barrier" electrode assembly was introduced and found to be useful for the anodic stripping determination of trace metal ions in the presence of surface active materials. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 7453, 7613, 7619, and 9158.

7497 (ARH-724(Add.)) COMPILATION OF PHYSICAL AND CHEMICAL PROPERTIES OF MATERIALS AND STREAMS ENCOUNTERED IN THE CHEMICAL PROCESSING DEPARTMENT. Krigens, A. G. (Atlantic Richfield Hanford Co., Richland, Wash.). July 24, 1968. 38p. Dep. CFSTI.

Addendum to HW-57386.

This document is issued as an addendum to HW-57386. Chemical and physical properties are given for plutonium nitrate, uranyl nitrate, and TBP–diluent. (M.C.G.)

7498 (CEA-R-3191) CONTRIBUTION TO THE STUDY OF ISOTOPIC EXCHANGE OF OXYGEN BETWEEN NICKEL OXIDE AND THE GASES ARISING FROM THE OXIDATION REACTION OF CARBON MONOXIDE. Bailly, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 101p. (In French). Dep.

Thesis. Submitted to Univ. of Lyon, France.

The three isotopic reactions of oxygen: $C^{18}O + Ni^{16}O \rightleftharpoons C^{16}O + Ni^{18}O$, $^{16}O^{18}O + Ni^{16}O \rightleftharpoons {}^{16}O_2 + Ni^{18}O$, and $C^{16}O^{18}O + Ni^{16}O \rightleftharpoons C^{16}O_2 + Ni^{18}O$ between CO, CO_2, O_2, and NiO were studied using a mass spectrometer. The isotopic gaseous mixtures were prepared from oxygen-18-enriched water. A first order kinetic law was found for these reactions in the gaseous phase, and the activation energies were determined. Only CO and CO_2 exchange oxygen, at room temperature, but only with part of the oxide surface. Gaseous O_2 reacts with the whole surface at 250°C. The slow step of the exchange process, in the gaseous phase, is mobility of oxygen ions on the surface of NiO. (auth)

7499 (CONF-681020-(Vol.2), pp 741-50) PREPARATION OF A NONSTOICHIOMETRIC SAMARIUM FLUORIDE PHASE. Stezowski, John J.; Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry).

The reduction of samarium trifluoride with elemental samarium resulted in the preparation of a cubic phase that exhibits a wide range of stoichiometry. This phase was observed to undergo rhombohedral distortion when the F/Sm ratio exceeds 2.4. Density measurements and lattice parameter determinations indicate the system may be represented by an interstitial anion model. (auth)

7500 (COO-1197-37) POINT DEFECTS IN IONIC CRYSTALS. Final Report. Friauf, Robert J. (Kansas Univ., Lawrence). Sept. 30, 1968. Contract AT(11-1)-1197. 14p. Dep. CFSTI.

Studies on diffusion of Ag in AgCl yielded quantitative data on collinear and noncollinear interstitialcy motion, and provided an absolute test for comparison of diffusion and ionic conductivity measurements. A new experimental technique of tracer diffusion in an electric field was used in studies of Na diffusion in NaCl. Studies on diffusion of Tl and Cl in TlCl confirmed diffusion by single vacancies with additional diffusion by either vacancy pairs or next nearest neighbor jumps. A method was devised for calculating correlation coefficients for the proposed new diffusion mechanisms in TlCl. Optical absorption experiments identified bands associated with Mg in LiF and with trapped dielectrons in alkaline ice. Photoconductivity measurements helped to substantiate recently proposed models for Z_2 and Z_3 centers in KCl:Sr. (J.G.B.)

7501 (COO-1675-5) KNUDSEN AND MOLECULAR DIFFUSION OF GASES IN CAPILLARIES AND POROUS SOLIDS OVER LARGE PRESSURE RANGES. Technical Progress Report, April 1, 1968-March 31, 1969. Geankoplis, Christie J. (Ohio State Univ., Columbus. Dept. of Chemical Engineering). Nov. 22, 1968. Contract AT(11-1)-1675. 16p. Dep.

Experimental data were recently obtained for diffusion of binary gases in different synthetic porous structures. Solids made and used contained one micropore size and many macropore sizes, several solids where the micropore structure was constant but the macropore radius was varied, and a solid where some of the micropores were blocked off by glass powder particles. Theoretical equations derived for these cases checked the experimental data. The data covered a 1300/1 pressure range which included the Knudsen and most of the transition region. A method was devised to make a plug containing 272 glass capillaries in parallel. Experiments are being made at various pressures to check the theoretical transition region equation. Also, various size capillaries and metal capillaries with rough walls will be used. A high pressure apparatus has been designed to extend the range of pressures covered to 345,000/1. An analytical solution to the differential equations for diffusion of a three-component gas mixture was obtained for the complete transition region in an open system. A numerical solution for the mixture of helium, neon, and argon showed the fluxes of helium and neon approaching constant values at high pressures as expected. The flux of argon indicated that osmotic diffusion occurs even though there is no concentration gradient. (P.C.H.)

7502 (DP-1148) PREPARATION OF REACTOR-GRADE UO_3 FROM UO_3 BY ARC FUSION. Goodlett, Claude B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1968. Contract AT(07-2)-1. 20p. Dep. CFSTI.

An arc-fusion process was developed that converts UO_3 to reactor-grade UO_2. UO_3 is fed to a carbon-arc furnace with internally insulated walls that maintain the temperature of the entire charge above the decomposition temperature of UO_3 (~650°C), and thereby eliminate diffusion of oxygen from UO_3 at the walls to product nearer the center. (auth)

7503 (RFP-1248) DESORPTION FROM PLUTONIUM DIOXIDE. Stakebake, Jerry L.; Dringman, Marston R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 21, 1968. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

The outgassing of plutonium dioxide, previously exposed to air, was investigated over the temperature range from 25 to 1000°C. This investigation broadened the perspective of the adsorption properties and gas-solid interactions of this material. Plutonium dioxide was found to exhibit a strong gettering action toward water vapor, carbon dioxide, and nitric oxide. Water vapor and carbon dioxide are adsorbed directly from the atmosphere. The nitric oxide is believed either to be adsorbed as a radiolysis product of air or to be the result of radiolytic decomposition of air in the adsorbed state. A qualitative comparison of the adsorption strengths of the major products is $CO_2 > NO > H_2O$. Approximately 95% of the adsorbed gases can be removed by outgassing the oxide at 700°C. (auth)

7504 ACTIVATION OF HYDROGEN AT 79°K BY SUPPORTED COPPER. Benson, J. E.; Walters, Arden B.; Boudart, M. (Stanford Univ., Calif.). J. Phys. Chem., 72: 4587-9 (Dec. 1968).

A new catalyst containing 500 ppM of copper on magnesium oxide was found to activate molecular hydrogen at 79°K as evidenced by its ability to catalyze the H_2-D_2 exchange at that temperature at a rate per surface atom comparable to that measured on metallic nickel. This catalyst is poisoned by adsorption of hydrogen at higher temperature. The nature of the surface sites responsible for the exchange is discussed. (auth)

7505 NEW H PHASES. Beckmann, O.; Boller, H.; Nowotny, H. (Univ., Vienna). Monatsh. Chem., 99: 1580-3(July-Aug. 1968). (In German).

The H phases of Nb_2PC, Nb_2AsC, and Nb_2SC were prepared. The powder diagrams of these phases were evaluated and the intensities were calculated. The values are tabulated. (J.S.R.)

7506 THE OXIDATION OF 4a, 4b-DIHYDROPHENANTHRENES: A LARGE KINETIC ISOTOPE EFFECT OF DEUTERIUM IN THE INITIATION STEP OF THE THERMAL REACTION WITH OXYGEN. Bromberg, A.; Muszkat, K. A.; Fischer, E. (Weizmann Inst. of Science, Rehovoth, Israel). Chem. Commun., No. 21, 1352-4(Nov. 6, 1968).

An unusually large kinetic isotope effect, $k_1^H/k_1^D = 95$ (at -31°), on the rate constant of the self-initiation step was found. Reaction mechanisms are discussed. It is concluded that the large effect is due both to a considerable loss of zero point energy of stretching and bending vibrations in the transition state and to a large contribution from quantum-mechanical tunnelling. It is also concluded that the rate-determining process is the transfer of a H-atom from the dihydrophenanthrene to O_2, and that the reaction takes place in only one specific configuration of the transition state. (UK)

7507 STABILITY CONSTANTS OF CHLORIDE COMPLEXES OF MONO-VALENT ASTATINE IN NITRIC ACID SOLUTION. Norseev, Yu. V.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem., 30: 3239-43(Dec. 1968).

Using the cation exchange method a mono-valent positive astatine ion was shown to form chloride complexes with one or two ligands in 0.5 M HNO_3 – 5×10^{-3} M $H_2Cr_2O_7$ – $(4 \pm 2) \times 10^{-2}$ M HCl solutions. The stability constants were determined to be $\beta_1 = 7 \times 10^2\ M^{-1}$ and $\beta_2 = 2.5 \times 10^5\ M^{-2}$. (auth) (UK)

7508 STUDIES ON THE DISPROPORTIONATION OF PLUTONIUM(V) IN OXALATE MEDIUM. Ghosh Mazumdar, A. S.; Khandelwal, S. C.; Natarajan, P. R. (Bhabha Atomic Research Centre, Bombay). J. Inorg. Nucl. Chem., 30: 3295-3304(Dec. 1968).

Plutonium(V) in oxalate solutions in the pH region 2 to 5.5 was found to be unstable to disproportionation, giving rise to plutonium(VI) and plutonium(IV). The rate of disproportionation is proportional to the second power of the plutonium(V) concentration and decreases with decreasing hydrogen ion concentration. The dependence of the rate and extent of disproportionation on pH, oxalate concentration, and plutonium concentration was studied. An activation energy of 10.0 kcal/mole was computed from the temperature dependence of the second order rate constant for the disproportionation of plutonium(V) in 0.03 M oxalate solution at pH 2. (auth) (UK)

7509 KINETICS OF PRECIPITATION OF FERRIC DIBUTYLPHOSPHATE FROM AQUEOUS HNO_3 SOLUTIONS. Davis, W. Jr.; Rester, D. O. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 30: 3317-24(Dec. 1968).

The kinetics of the precipitation of iron(III) dibutylphosphate in 1, 3, and 5 M HNO_3 were studied at an initial Fe^{3+} concentration of 231 mg/l (4.14 mMoles) and at initial dibutylphosphoric acid (HDBP) concentrations of 3.06 and 1.53 g/l (14.56 and 7.28 mMoles). The experimental data on Fe^{3+} concentration (C, moles/l) were used to obtain the nonlinear parameters of the

integrated form of the rate equation $dC/dt = -k\,(C-S_{Fe})^n$. This equation is obtained from a more general expression of the form $dC/dt = -k'(C - S_{Fe})^p(C_D - S_D)^q$, where C_D and S_D are, respectively, instantaneous and final (i.e., its solubility) concentrations of dibutylphosphate, and S_{Fe} is the final (solubility) concentration of Fe^{3+}. The assumed reaction, $Fe^{3+} + 3\,HDBP \rightleftharpoons Fe(DBP)_3 + 3H^+$, appears to have a combined order n(=p + q) of approximately 2; the rate constant (k) is of the order of 10^{-3} to 10^{-2} when time is expressed in minutes. The value of the solubility product increases from about 2×10^{-13} to 2×10^{-12} (moles/l)^4 as the nitric acid concentration increases from 1 to 5 M. These studies are of interest in connection with the TBP process for the reprocessing of fast reactor fuels. (auth) (UK)

7510 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. PART IV. THE HYDROLYSES OF SOME FLUORO-COMPLEXES IN NEUTRAL, ACIDIC, AND BASIC SOLUTIONS. Chan, S. C.; Hui, K. Y.; Lau, O. W. (Univ. of Hong Kong). J. Chem. Soc., A, No. 12, 2902-6(1968).

Fluoropenta-[$^2H_3$]amminecobalt(III) nitrate was prepared and characterized, and the kinetics of its hydrolyses in neutral, acidic, and basic deuterium oxide solutions were investigated. The deuterium isotope effect observed is compared, where possible, with that previously reported for the reactions of the corresponding chloro-complex. To determine the effect of changing the central metal, the kinetic study was extended to the corresponding chromium(III) complex. In addition, trans-difluorobis(ethylenedi-[$^2H_3$]amine)cobalt(III) nitrate was prepared and characterized, and similar kinetic investigations made. The resulting deuterium isotope effect did not differ significantly from that in the reactions of the bivalent fluoropenta-ammine system. (auth) (UK)

7511 MOTION OF PROTONS AND DEUTERONS IN PALLADIUM UNDER THE INFLUENCE OF AN ELECTRIC FIELD. Knaak, Joachim; Eichenauer, Walter (Technische Hochschule, Dramstadt, Ger.). Z. Naturforsch., 23a: 1783-9(Nov. 1968). (In German).

The electromigration of hydrogen and deuterium in the α phase of H–Pd or D–Pd systems was investigated. The experiments were carried out with an isobaric measurement arrangement between 250 and 350°C and 50 to 760 torr. The solubility of hydrogen in palladium was determined at 200 to 450°C. (tr-auth)

7512 ANOMALOUS TEMPERATURE DEPENDENCE OF KINETIC CARBON ISOTOPE EFFECTS AND THE PHENOMENON OF CROSSOVER. Huang, Thomas T.-S.; Kass, William J.; Buddenbaum, Warren E.; Yankwich, Peter E. (Univ. of Illinois, Urbana). J. Phys. Chem., 72: 4431-46(Dec. 1968).

The effects of diagonal and off-diagonal stretching force constant variations on the temperature-dependent and temperature-independent factors in the intramolecular isotopic rate constant ratio for the decomposition of oxalic acid-^{13}C were explored. Crossover (change in sense with respect to unity) of the temperature-dependent factor was not observed when the reaction coordinate consists of a single internal coordinate displacement. When a zero frequency was achieved by employing one large off-diagonal force constant (two elements in the reaction coordinate), crossover was observed only if the basic diagonal force field was asymmetric at one or more isotopic bonds. If the reaction coordinate contains three or more elements (two or more nonzero off-diagonal force constants are employed), anomalies of temperature dependence can be generated with symmetric diagonal force fields. Two new techniques for study of the effects of systematic variation of the composition of the reaction coordinate are introduced and/or applied. (auth)

7513 PHYSICO-CHEMICAL STUDIES OF AMMONIUM PENTAFLUOXYURANATE. II. EXAMINATION OF INFRARED SPECTRA OF $(NH_4)UO_2F_3$ AND $K_3UO_2F_5$. ANALYSIS IN NORMAL COORDINATES OF THE $UO_2F_5^{3-}$ ION. Nguyen-Quy-Dao (Ecole Normale Superieure, Paris, Faculte des Sciences, Paris). Bull. Soc. Chim. Fr., No. 10, 3976-81(Oct. 1968). (In French).

Infrared absorption bands of the compounds $K_3UO_2F_5$ and $(NH_4)_3UO_2F_5$ have been attributed in the range of wave numbers between 400 and 33 cm^{-1}. Confirmation is made by an analysis in normal coordinates of the $UO_2F_5^{3-}$. The force constants of the U–O and U–F bonds are respectively 6.20 mdynes Å^{-1} and 5.00 mdynes Å^{-1}. The $UO_2F_5^{3-}$ ion in ammonium pentafluoxyuranate (indexed as ammonium uranyl fluoride) is slightly deformed with respect to the configuration of the pentagonal bipyramid with D_{5h} symmetry. (auth)

7514 CRYSTALLOGRAPHIC STUDY OF URANIUM SELENIDE U_2Se_5, PARAMETERS AND SPACE GROUP. Mazurier, Alain; Khodadad, Parviz (CNRS, Grenoble, France. Faculte de Pharmacie, Paris). Bull. Soc. Chim. Fr., No. 10, 4058(Oct. 1968). (In French).

A study of monocrystals of U_2Se_5 by x-ray diffraction has not led to the determination of the structure. The following characteristics are given for the orthorhombic lattice: a = 8.49 Å ± 0.02, b = 12.27 Å ± 0.02, c = 7.75 Å ± 0.02; d(calculated = 9.14 g/cm^3, d(experimental) = 9.04 g/cm^3, possible space group Pnmb and $P2_1nb$. (auth)

7515 SELECTIVE SOLVATION IN AQUEOUS N-METHYLACETAMIDE: AN NMR STUDY OF SPECIFIC ION EFFECTS. Hinton, J. F.; Amis, E. S.; Mettetal, W. (Univ. of Arkansas, Fayetteville). Spectrochim. Acta, 25A: 119-30(Jan. 1969).

Selective solvation in aqueous N-methylacetamide solutions of $AlCl_3$, $Al(ClO_4)_3$, $Al(NO_3)_3$, $Th(NO_3)_4$, $Mg(ClO_4)_2$, and $LiClO_4$ was studied using nuclear magnetic resonance. The effect of changes in solvent composition and electrolyte concentration on the solvating properties of water and N-methylacetamide in these solutions was investigated. Separate bulk and bound resonance signals were obtained for N-methylacetamide in the solutions containing the aluminum salts. The relative degree of solvation of the cations by water and N-methylacetamide was found to be $Al^{+3} > Th^{+4} > Mg^{+2} > Li^{+1}$ while the order obtained for the anions studied was $Cl^{-1} > NO_3^{-1} > ClO_4^{-1}$. (auth) (UK)

7516 CHEMISTRY OF ACTINIUM-II. STABILITY CONSTANTS OF THIOCYANATE COMPLEXES OF ACTINIUM AND LANTHANUM. Rao, C. L.; Shahani, C. J.; Mathew, K. A. (Bhabha Atomic Research Center, Trombay, India). Inorg. Nucl. Chem. Lett., 4: 655-9(Nov. 1968).

A determination of the stability constants of the thiocyanate complexes of Ac^{3+} and La^{3+} in a solution of unit ionic strength and pH 2.0 at 27°C is described, employing a solvent extraction technique involving the use of a benzene solution of the sodium salt of dinonyl naphthalene sulphonic acid. ^{228}Ac and ^{140}La were used as tracers. Data on the variation of the distribution coefficient with thiocyanate concentration are tabulated, from which stability constants were calculated. (UK)

7517 KINETIC ISOTOPE EFFECT IN REACTION BETWEEN 4-NITROBENZYL CYANIDE AND ETHOXIDE ION IN ETHANOL + ETHER. Caldin, E. F.; Tomalin, G. (Univ. of Kent, Canterbury, Eng.). Trans. Faraday Soc., 64: 2814-22(Oct. 1968).

The rate of the deuteron-transfer reaction between ethoxide ion and 4-nitrobenzyl cyanide-α,α-d_2 was determined at six temperatures over the range −40 to −90°C. At the highest temperatures the Arrhenius plot showed a negative deviation from linearity, and approached that for the proton-transfer; this behavior confirms the previous interpretation in terms of an unstable intermediate complex. At lower temperatures (−60 to −90°C) the plot for the deuteron-transfer reaction was linear; the energy of activation was 1.8$_5$ ± 0.2 kcal mole^{-1} higher than for the proton-transfer, and the A-factor was about 5 times larger. These values can be interpreted in terms of tunneling. On fitting the equations for a parabolic energy-barrier, with $\Delta H^0 = 0$, the height is found to be 10.3 kcal mole^{-1} and the width 1.63 Å. These are in good agreement with the values found independently from the nonlinear Arrhenius plot for the proton-transfer reaction in the same medium (10.7 kcal mole^{-1} and 1.62 Å). (auth) (UK)

7518 A MASS SPECTROMETRIC STUDY OF THE NEUTRAL AND POSITIVE IONIC SPECIES INVOLVED IN CARBON DEPOSITION FROM R. F. DISCHARGES IN CARBON-CONTAINING GASES. Evans, H. E.; Jennings, P. P. (Berkeley Nuclear Labs., Eng.). Carbon, 6: 695-705(Oct. 1968).

A mass spectrometric study was made of species present in rf discharges in binary mixtures of CO_2, CO, CH_4, O_2, and He. The positive ion spectra were correlated with observations of deposit formation. Rates of formation and oxidation of deposits were measured gravimetrically. Deposits were formed from all CO/CH_4 mixtures and from a number of the other mixtures. In the absence of CH_4 the ions C^+, C_2O^+, $C_3O_2^+$ (and possibly C_3^+) or their neutral precursors were thought to be involved in deposition. In CH_4-containing mixtures the ion distribution was dependent on the nature of the reacting gases. It was deduced that reactions of the sort: $CH_x + O \rightarrow CH_{x-1} + OH \rightarrow CH_{x-2} + H_2O$ were important in the system, and that deposition from mixtures containing CH_4 and O_2 involved reactions of CH_x in this way. The results are interpreted as showing that deposition and corrosion reactions occur simultaneously. Deposition occurs when the rate of the deposition reaction exceeds that of the corrosion reaction. (auth) (UK)

7519 PHOTOLYSIS OF HEXAFLUOROACETONE IN THE PRESENCE OF H_2, D_2, AND HD. KINETIC ISOTOPE EFFECTS IN THE REACTION OF CF_3 WITH MOLECULAR HYDROGEN. Kibby, Charles L.; Weston, Ralph E. Jr. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 49: 4825-40(Dec. 1, 1968).

The photolysis of hexafluoroacetone was used as a source of CF_3

radicals which either react with hydrogen to produce fluoroform or recombine to form hexafluoroethane. Relative rates of these reactions approximately obey the Arrhenius expressions over the temperature range from 333 to 870°K, $k_{H_2}/2k_2^{\frac{1}{2}} = 9.3 \times 10^3 \exp[(-10,660 \pm 140)/RT]$ liter$^{\frac{1}{2}}$ mole$^{-\frac{1}{2}}$ sec$^{-\frac{1}{2}}$, $k_{HD}/k_2^{\frac{1}{2}} = 7.4 \times 10^3 \exp[(-10,770 \pm 150-/RT]$, $k_{DH}/k_2^{\frac{1}{2}} = 9.6 \times 10^3 \exp[(-11,630 \pm 130)/RT]$, $k_{D_2}/2k_2^{\frac{1}{2}} = 6.9 \times 10^3 \exp[(-11,660 \pm 110)/RT]$. Direct measurements of isotope effects were obtained by mass spectrometric analysis of the fluoroform produced during photolysis with added H_2/D_2 mixtures or with HD. Rate constant ratios are $k_{H_2}/k_{D_2} = 1.30 \exp(1050/RT)$, $k_{HD}/k_{DH} = 0.78 \exp(860/RT)$. The observed isotope effects are compared with those calculated on the basis of three- and six-atom LEPS and BEBO models for the activated complex. (auth)

7520 HIGH-TEMPERATURE THERMODYNAMIC PROPERTIES OF OXYGEN-DEFICIENT URANIA. Tetenbaum, M.; Hunt, P. D. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4739-44(Dec. 1, 1968).

Measurements of oxygen partial pressures over oxygen-deficient urania compositions, including the difficult region very close to stoichiometry, were made in the temperature range from 2080 to 2705°K. The transpiration method was used with flowing H_2-H_2O mixtures in order to fix the oxygen potential of the carrier gases. The shape of the isotherms are qualitatively in accord with expectations based on defect theory. At the lower temperatures (2080 to 2390°K), the isotherms exhibit a sharp increase in oxygen partial pressure near the stoichiometric composition. At the higher temperatures (2495 to 2705°K), large deviations from the stoichiometric composition are accompanied by relatively small changes in oxygen partial pressures. Relative partial molar free energies, entropies, and enthalpies of solution were calculated and discussed in relation to defect theory. (auth)

7521 MILLIMETER-WAVE SPECTRA AND MOLECULAR CONSTANTS OF ^{6}LiD AND ^{7}LiD. Pearson, Edwin F.; Gordy, Walter (Duke Univ., Durham, N. C.). Phys. Rev., 177: 59-61 (Jan. 5, 1969).

The $J = 0 \rightarrow 1$ rotational line of LiD was measured in the ground vibrational state and in the first excited state. The measurements provided values of the frequencies and the spectral constants.

	ν_0(Mc/sec)	ν_1(Mc/sec)	Y_{01}(Mc/sec)
^{6}LiD	260,306.96 ± 0.05	254,596.63 ± 0.05	131,615.07 ± 0.04
^{7}LiD	251,043.53 ± 0.05	245,635.62 ± 0.05	126,905.36 ± 0.04

	Y_{11}(Mc/sec)	B_e(Mc/sec)
^{6}LiD	−2898.90 ± 0.04	131,673 ± 4
^{7}LiD	−2744.61 ± 0.04	126,961 ± 4

The value of r_e, which is independent of isotopic substitution, was found to be 1.59490 ± 0.00002 Å. From these constants the corresponding values for the LiH species were derived. (auth)

7522 NUCLEAR QUADRUPOLE RESONANCE SPECTRA OF ^{75}As IN SOME DIHYDROGEN ARSENATES AND OF THEIR DEUTERIATED ANALOGUES. Zhukov, A. P.; Golovchenko, L. S.; Semin, G. K. (Inst. of Elemento-Organic Compounds, Moscow). Chem. Commun., No. 15, 854-5(1968).

Pure NQR spectra of ^{75}As were studied in some polycrystalline dihydrogen arsenates MH_2AsO_4 (M = Li, K, Na, Rb, Cs, Ag, NH_4, Me_4N) and their deuteriated analogues. Data are tabulated. The NQR frequency is determined by the electric field gradient at the ^{75}As site and hence can serve as a measure of the distortion of the AsO_4 tetrahedron. This distortion arises mainly from the intermolecular hydrogen bonds O−H ... O and their dynamical changes. The contribution to the field gradients arising from ionically bonded metal atoms is not, however, small since the resonant frequencies depend on these atoms. For the ferroelectric crystals (M = K, Rb, Cs, and NH_4) the frequencies decreased sharply with increase in temperature, and this could not be accounted for by increase in thermal lattice oscillations; it was probably a result of intrabond protonic mobility. No sharp frequency change was observed for non-ferroelectric crystals. On replacing hydrogen by deuterium a remarkable isotope effect was observed, the difference between the frequencies in K, Rb, and Cs compounds at 77°K almost completely vanishing. (UK)

7523 RAMAN SPECTRUM OF NEPTUNIUM HEXAFLUORIDE. Gasner, Earl L.; Frlec, Boris (Argonne National Lab., Ill.). J. Chem. Phys., 49: 5135-7(Dec. 1, 1968).

The three Raman active fundamentals of NpF_6 have been observed at 654 (ν_1), 535 (ν_2), and 208 cm^{-1} (ν_5) for the gas and at 651 (ν_1) p, 524 (ν_2) dp, and 218 cm^{-1} (ν_5) dp, for the liquid. The values observed for the gaseous sample were within 7 cm^{-1} of the values calculated by Malm, Weinstock, and Claassen on the basis of infrared combination bands. Spectra were obtained through the use of a 6328-Å He−Ne laser-excited, photoelectric recording Raman spectrophotometer. (auth)

7524 THERMOCHEMISTRY OF UOS; EVAPORATION OF US–UO_2 MIXTURES; ON THE ATTAINMENT OF EQUILIBRIUM IN KNUDSEN CELLS. Cater, E. David (Univ. of Iowa, Iowa City); Rauh, E. G.; Thorn, R. J. J. Chem. Phys., 49: 5244-53(Dec. 15, 1968).

Evaporation of mixtures of US and UO_2 and of UOS has been studied by molecular effusion, and the gaseous species have been investigated mass spectrometrically. A eutectic occurs in the system US−UO_2 at 2240°K and at approximately 45% dioxide. In the vapor the gaseous species in order of decreasing partial pressures are: UO, UO_2, UOS, US, S, U, and O. Because of the formation of the gaseous monoxide, the total pressure is about twice the sum of the vapor pressures for US and UO_2 alone. Calculated as though the vapor had the molecular weight of the monoxide, the total "effective" vapor pressure is given by $\log P_E(atm) = -(3.496 \pm 0.064)10^4/T + (10.870 \pm 0.298)$ below the eutectic temperature and $\log P_E(atm) = -(2.450 \pm 0.181)10^4/T + (6.277 \pm 0.755)$ above this temperature. The energy of atomization of gaseous UOS is 300 ± 7 kcal/mole at 0°K. In general, the mass-spectrometric measurements were much less precise and reproducible than those in previous studies of simpler systems with the same equipment. This was believed to be due to non-equilibrium conditions in the condensed phases in the Knudsen cell. It was concluded that the condensed phases must be studied as well as the vapor phase before assuming that mass spectrometrically studied isomolecular reactions will yield equilibrium thermodynamic data. (auth)

7525 TEMPERATURE DEPENDENCE OF KINETIC ISOTOPE EFFECTS IN GAS-PHASE REACTIONS. I. THEORY OF THE HIGH-TEMPERATURE LIMIT. Tschuikow-Roux, E.; MacDonald, Digby D. (Univ. of Calgary, Alberta). J. Chem. Phys., 49: 5342-5(Dec. 15, 1968).

The theory of the high-temperature limit of the temperature dependence of the kinetic isotope effect in gas-phase reactions is discussed in detail and the resulting high temperature limit is interpreted in terms of contributions from the initial states and activated complexes. (auth)

7526 TEMPERATURE DEPENDENCE OF KINETIC ISOTOPE EFFECTS IN GAS-PHASE REACTIONS. II. THE HYDROGEN-ATOM–FORMALDEHYDE REACTION. MacDonald, Digby D.; Tschuikow-Roux, E. (Univ. of Calgary, Alberta). J. Chem. Phys., 49: 5345-9(Dec. 15, 1968).

Kinetic isotope effects of atom-transfer reactions and their temperature dependences at high temperatures have been calculated for various hydrogen atom−formaldehyde reactions. In the case of the "abstracting atom" kinetic isotope effect, a negative temperature coefficient is predicted in the high-temperature limit. The theoretical calculations were compared with experimental results in the literature and satisfactory agreement was obtained. (auth)

7527 THE UF_4–UF_3 SYSTEM. Khripin, L. A.; Poduzova, S. A.; Zadneprovskii, G. M. Zh. Neorg. Khim., 13: 2796-9(Oct. 1968). (In Russian).

The binary system UF_4-UF_3 was studied by differential thermal and x-ray analysis. The system is related to the simple eutectic type without the formation of solid solutions. The eutectic point occurs at 879°C at a composition of about 33 mole % UF_3. (tr-auth)

7528 NEW METHOD OF OBTAINING THE OXYCHLORIDE OF HEXAVALENT URANIUM UO_2Cl_2. Glukhov, I. A.; Eliseev, S. S.; Vozhdaeva, E. E. Zh. Neorg. Khim., 13: 2892-3(Oct. 1968). (In Russian).

A method is described for obtaining UO_2Cl_2 by the exchange reaction between $MoOCl_4$ and UO_3. The uranyl chloride was characterized qualitatively by infrared spectral analysis. (tr-auth)

7529 PHASE DIAGRAMS OF THE SYSTEMS $Li_2SO_4-R_2(SO_4)_3$ (R = Eu^{3+}, Gd^{3+}, AND Tb^{3+}). Volk, V. I.; Zaitseva, L. L.; Il'yashenko, V. S. Zh. Neorg, Khim., 13: 2818-24(Oct. 1968). (In Russian).

On the basis of thermal data and x-ray and spectral analyses, phase diagrams were constructed for the systems, $Li_2SO_4-Eu_2(SO_4)_3$, $Li_2SO_4-Gd_2(SO_4)_3$, and $Li_2SO_4-Tb_2(SO_4)_3$. It was established that in these systems, incongruent compounds of the composition $LiR(SO_4)_2$ were formed. Experimental curves for the Li_2SO_4 liquidus were compared and confirmed the chemical nature of the eutectics. (tr-auth)

7530 $TeCl_4-MCl_n$ (M = Sb, Bi, Mo, W; n = 3,5,6) SYSTEMS. Safonov, V. V.; Korshunov, B. G. Zh. Neorg. Khim., 13: 2804-6 (Oct. 1968). (In Russian).

A fusion method was used to study interaction of tellurium tetrachloride with the chlorides of antimony, bismuth, molybdenum, and tungsten in melt. Fusion diagrams were constructed for the systems $TeCl_4-SbCl_3$, $TeCl_4-BiCl_3$, $TeCl_4-MoCl_5$, and $TeCl_4-WCl_6$. The eutectic character of the fusion diagrams was confirmed by calculations and by crystal-optics studies. (tr-auth)

7531 KINETICS OF HOMOMOLECULAR ISOTOPIC EXCHANGE OF OXYGEN ON SAMARIUM OXIDE. Sokolovskii, V. D.; Sazonov, L. A.; Boreskov, G. K.; Moskvina, Z. V. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Katal., 9: 784-8(July-Aug. 1968). (In Russian).

The kinetics of homomolecular isotopic exchange of oxygen on samarium oxide was studied in a wide range of temperatures and pressures (−145 to +350°C and from 5 to 40 mm Hg). The anomalous temperature of the reaction was observed. It was assumed that the homomolecular exchange proceeds simultaneously according to two mechanisms, which are distinguished by a limiting stage and by the forms of adsorption participating in the exchange of oxygen. At temperatures above 150°C the main contribution to the exchange is the adsorption-desorption mechanism. At temperatures below 150°C the mechanism was limited to exchanges between adsorbed molecules of oxygen. The initial heat of adsorption of oxygen, which participates in low temperature exchange, was evaluated. (tr-auth)

7532 ISOTOPE EFFECTS IN THE PHOTOIONIZATION YIELDS AND THE ABSORPTION CROSS SECTIONS FOR ETHYLENE AND n-BUTANE. Person, James C.; Nicole, Paul P. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 5421-37(Dec. 15, 1968).

The absorption cross section σ and the photoionization yield η (the probability that photon absorption produces ionization), are reported for C_2H_4 and C_2D_4 at 44 photon energies between 10.44 and 11.78 eV, and they are reported for n-butane and n-butane-d_{10} at 37 photon energies between 10.56 and 11.78 eV. For ethylene, the nature of the isotope effects on η, σ, and the photoionization cross sections, $\sigma_1(\sigma_1 = \eta\sigma)$, indicates that the increase in η upon deuteration is not the result of a simple competition between preionization processes and atomic-rearrangement processes in the superexcited states. The isotope effects for n-butane and the implications of the results for radiation chemistry are also discussed. (auth)

7533 THE KINETICS OF ISOTOPIC EXCHANGE OF HYDROGEN BETWEEN THIOHYDRYL AND CARBOXYL GROUPS. ISOBUTYLMERCAPTAN–ISOBUTYRIC ACID IN CCl_4. Denisov, G. S.; Smolyanskii, A. L. (Scientific-Research Physical Inst., Leningrad). Kinet. Katal., 9: 902-6(July-Aug. 1968). (In Russian).

Infrared spectroscopy was used to measure the rate of hydrogen exchange between the carboxyl group of isobutyric acid and the thiohydryl group of isobutylmercaptan (2-methyl-1-propanethiol) in CCl_4 solution at temperatures from −8 to +16°C. The energy of activation of the bimolecular process was found to be 13 kcal/mole. (tr-auth)

7534 CATALYTIC PROPERTIES OF RARE-EARTH ELEMENTS IN ISOTOPIC EXCHANGE REACTIONS IN MOLECULAR OXYGEN. Antoshin, G. V.; Minachev, Kh. M.; Dmitriev, R. V. (Inst. of Organic Chemistry, Moscow). Kinet. Katal, 9: 816-23 (July-Aug. 1968). (In Russian).

In the temperature range 300 to 420°C and at oxygen pressures of 20 to 80 mm Hg the kinetics of isotopic exchange of molecular oxygen on thirteen rare earth oxides was studied. It was found that the reaction activity of rare earth oxides is similar to the activity of fourth period metal oxides. Variations in activity of rare earth oxides upon transition from one oxide to another is in agreement with the structure of the rare earth 4f subshells. In the cerium and yttrium subgroups the oxides of praseodymium and terbium possess maximum activity. Exchanges of molecular oxygen take place by exchange between the gas and oxide phases. (tr-auth)

7535 VAPOR PRESSURE OF THE ISOTOPIC ETHYLENES. IV. LIQUID ETHYLENE-d_2 AND -d_4. Ishida, Takanobu; Bigeleisen, Jacob (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 49: 5498-509(Dec. 15, 1968).

The purification of ethylene gas samples (200 to 400 cc NTP) to a chemical purity of 99.9997% is described. The vapor pressures of liquid ethylene-d_2 and ethylene-d_4 have been measured and compared with that of C_2H_4 in the temperature range 115 to 180°K. The reduced partition function ratios of liquid D_2HD_3/C_2H_4 and C_2D_4/C_2H_4 compared to the ideal-gas reference state are derived from the vapor-pressure measurements. The experimental reduced partition function ratios of the liquid are in satisfactory agreement with cell model calculations of Stern, Van Hook, and Wolfsberg. The latter calculations have been extended to include interaction force constants between the internal and external modes as well as the external modes among themselves. The experimental partition function ratios show significant curvature in a plot of $\ln f_c/f_g$ vs $1/T$ in contrast to the almost linear behavior inherent in the harmonic oscillator model. Analysis of the curvature shows that the mean square intermolecular force in liquid ethylene decreases by a factor of 2 in the temperature range from 104 to 180°K. Correlations of the liquid partition function ratio with the liquid density are consistent with a short-range intermolecular force. (auth)

7536 FAR INFRARED ABSORPTION SPECTRA OF H_2S AND D_2S. Osaka, Toshiaki; Takahashi, Shin-ichi (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 25: 1654-63(Dec. 1968).

Using a far infrared spectrometer with a variable depth grating, measurements of the pure rotation spectra of H_2S and D_2S were extended into longer wavelengths from 300 to 1500 mμ. The instrument is calibrated by the pure rotation spectra of H_2O, N_2O, and CH_3F. The accuracy of the measured wavelength is about ±0.2%. The transition frequencies of H_2S and D_2S were calculated according to the Kivelson–Wilson's formula. A comparison was made between the observed spectrum and the calculated spectrum, in which the relative intensities for D_2S were computed with the table of line strengths for rigid asymmetric rotor. By combining the two microwave transitions reported by Burrus and Gordy with the present data, the ground-state rotational constants (in cm^{-1}) were obtained: A = 10.357, B = 9.013, and C = 4.727 for H_2S; they were obtained from the present data: A = 5.489, B = 4.511, and C = 2.43? for D_2S. (auth)

7537 POLAROGRAPHIC AND CHRONOPOTENTIOMETRIC BEHAVIORS OF URANYL ION IN FUSED POTASSIUM THIOCYANATE. Yanagi, Tadashi; Nagata, Takashi (Osaka Univ.). Porarografii, 15: 102-7(Oct. 1968).

Using dropping mercury electrode, the electrochemical behavior of UO_2^{2+} dissolved in fused KCNS at 185°C was investigated through ordinary polarography and chronopotentiometry. Reproducible polarogram and chronopotentiogram, both consisting of two reduction waves for UO_2^{2+}, were obtained. Limiting current for the first step of the polarogram was proportional to the UO_2^{2+} concentration and the square root of the mercury height at constant depolarizer concentration, but not for the second. No linear relationship was obtained in the log $[i/(i_d-i)]$ vs E plots for both the first and second waves. The $i_d\tau_1^{1/6}$-values for the first step of chronopotentiogram at constant UO_2^{2+} concentration were independent of the current density at the polarized electrode and proportional to the bulk concentration. A plot of log $[(\tau_1^{1/6}-t^{1/6})/t^{1/6}]$ vs E yields a straight line for the first step and the average reciprocal slope (0.0993) is in good agreement with the theoretical value (0.091) in the case of n = 1 at 185°C. The ratio of τ_2/τ_1 was calculated for two successive reduction steps to be about 3. According to these observations it is clearly concluded that electroreduction process of UO_2^{2+} is diffusion-controlled and proceeds to two steps as follows: $UO_2^{2+} + e = UO_2^{+}$ and $UO_2^{+} + e = UO_2$. The diffusion constant of UO_2^{2+} in this melt at 185°C was calculated from Sand's equation to be 6.56×10^{-7} cm^2/sec, which is about one-third compared with that for lead ion in the same melt at the same temperature. (NSA of Japan)

7538 EXPERIMENTAL STUDY OF THE LIQUID-VAPOR EQUILIBRIUM OF THE BINARY MIXTURE UF_6–FREON 114 AT A 2600 TORR PRESSURE. Carles, M.; Aubert, J. (CEA, Paris). Chim. Ind., Genie Chim., 100: 211-17(July 1968). (In French).

The study of liquid–vapor equilibrium in the binary system UF_6–Freon 114 at a constant pressure, investigated by Barber et al. at 2,070 mm Hg (AEC Report K-1075) has been re-examined at 2,600 mm Hg. The installation used was the same as the one developed in previous studies (Chimie et Industrie-Génie Chimique 1967, 98, 4, pp. 661-668). It is all made of monel with aluminum or Kel-F joints. Homogeneity of liquid is achieved by magnetic stirring and also by returning gas in the liquid by means of an electromagnetic pump. Molar composition determination of gaseous and liquid phases is performed by means of an infrared spectrophotometer and a monel cell provided with silver chloride windows. The plotting of equilibrium diagram shows a complete miscibility over the whole range of concentrations, the temperatures varying from 40 to 92.5°C. Activity coefficient varies from 1 to 3.3 for UF and from 1 to 1.2 for Freon 114. (auth)

7539 POLAROGRAPHY OF URANIUM IN MONOCHLORO ACETIC ACID AND PYRIDINE MEDIA. Mehta, M. M.; Saraiya, S. C.; Sundaram, A. K. (Atomic Energy Establishment, Trombay, India). Indian J. Appl. Chem., 30: Nos. 3–4, 105-9(1967).

The polarography of uranium in monochloro acetic acid (MCA) and pyridine media is reported. In the presence of MCA three waves were obtained due to the stepwise reduction of uranium(VI) to uranium(III). In the presence of pyridine, at low pH, two waves were obtained due to the reduction of uranium(VI) to (V) and to (III). At pH above 3, two waves were obtained and the second wave appeared to be due to the reduction of uranium(V) to (IV). (auth)

7540 FORMATION OF HYDRATED COMPLEXES STARTING WITH URANIUM TETRAFLUORIDE FROM MANGANESE DIFLUORIDE AND ZINC DIFLUORIDE TETRAHYDRATE. Montoloy, Francois; Maraval, Simone (CEN de Saclay, Gif-sur-Yvette, France. Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., Ser. C, 267: 1309-11(Nov. 13, 1968). (In French).

By the reaction of UF_4 with MnF_2 and $ZnF_2 \cdot 4H_2O$ in a 40% hydrofluoric acid medium compounds corresponding to the formulas $MnUF_6 \cdot 3H_2O$ and $ZnUF_6 \cdot 5H_2O$ were obtained. (tr-auth)

7541 ELECTROCHEMICAL REDUCTION OF U(IV) IN MOLTEN LiF–BeF_2–ZrF_4 (65.6-29.4-5.0 MOLE PERCENT). EVIDENCE FOR ADSORPTION OF U(IV). Mamantov, Gleb (Univ. of Tennessee, Knoxville); Manning D. L. J. Electroanal. Chem. Interfacial Electrochem., 18: 309-14(1968).

Voltammetric and chronopotentiometric results at fast scan rates and short transition times, respectively, indicate the presence of weak adsorption of U(IV) at platinum and platinum–rhodium (10%) working electrodes at 500°C. Data for concentration-dependence are presented. The variation of the shape of voltammograms with temperature is discussed. (auth)

7542 DISPROPORTIONATION OF ELECTROCHEMICALLY-GENERATED URANIUM(V) IN MOLTEN LiF–BeF_2–ZrF_4 AT 500°. Manning, D. L. (Oak Ridge National Lab., Tenn.); Mamantov, Gleb. J. Electroanal. Chem. Interfacial Electrochem., 17: 137-41 (1968).

Electrochemical oxidation of U(IV) was studied in molten LiF–BeF_2–ZrF_4 (65.6–29.4–5.0 mole %) at 500°C by means of voltammetry (scan rate, v, 0.01 to 100 V/sec), chronopotentiometry, and chronoamperometry at unsheathed pyrolytic graphite and Pt–10% Rh electrodes. The following results point to the disproportionation of the electrochemically produced U(V): no voltammetric currents owing to the re-reduction of the product at $v \ll 1$ V/sec, the peak currents (i_p) for the oxidation of U(IV) and re-reduction of the product being approximately equal at $v \gg 1$ V/sec; peak currents for the reduction of U(IV) to U(III) and the oxidation of U(IV) are the same at large scan rates; the observed increase in $i_p/v^{1/2}$ vs. v at $v < 1$ V/sec; the observed variation of $i_0 \tau^{1/2}$ with $i_0^{1/2}$ is in agreement with theoretical predictions of Fischer and Dracka. At Pt–10% Rh electrodes, evidence for the adsorption of U(IV) was obtained. The reproducibility of voltammograms and chronopotentiograms for the oxidation process is poor, presumably owing to attack of the working electrode by U(VI) produced in the disproportionation. (auth)

7543 INFRARED SPECTRUM IN POLARIZED LIGHT OF CH_2Br_2 AND CD_2Br_2. DETERMINATION OF THE CRYSTAL STRUCTURE. Marzocchi, M. P.; Manzelli, P.; Schettino, V.; Califano, S. (Univ., Florence). J. Chem. Phys., 49: 5438-44 (Dec. 15, 1968).

The infrared spectra of crystalline CH_2Br_2 and CD_2Br_2 were measured at liquid-nitrogen temperature, between 4000 and 200 cm^{-1}. Splitting of the normal modes was observed for several fundamentals. These data, together with polarization measurements on polycrystalline oriented films, were used to study the crystal structure of CH_2Br_2. The technique of mixed crystals was used to prove the nature of the observed crystal splittings. The data accumulated on this molecule are consistent with a monoclinic $C_{2h}^5(P2_1/c)$ unit cell or with a triclinic $C_i^1(P\bar{1})$ cell with two sets of sites. The differences are discussed in terms of close packing. (auth)

7544 KINETIC STUDIES OF THE CATALYTIC ORTHO-PARAHYDROGEN CONVERSION AND HYDROGEN–DEUTERIUM EQUILIBRATION ON γ-ALUMINA. Ohno, Seigo; Yasumori, Iwao (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 41: 2227-33(Oct. 1968).

Kinetic studies of the catalytic ortho-parahydrogen conversion and hydrogen–deuterium equilibration on highly purified γ-alumina were conducted in the temperature range from 77 to 221°K and in the pressure range from 10 to 120 mm Hg. The rate equation obtained can be well explained by a mechanism which involves the reaction between an adsorbed atom and a molecule. The true activation energy, E, and the heat of adsorption of the reactive molecule, Q, were estimated as E = 0.51 to 0.80 and Q = 0.51 to 0.72 kcal/mole for the conversion (77 to 195°K), and E = 4.6 and Q = 1.9 kcal/mole for the equilibration (145 to 221°K). The conversion at temperatures below 90°K was found to proceed mostly via the magnetic mechanism. A thermal desorption study of adsorbed ethylene showed that there are three types of adsorption on γ-alumina with different activation energies of desorption, and that these species occupy a total of only a few hundredths of the surface. It is concluded that the most strongly adsorbed ethylene blocks the reactions via the chemical mechanism, while the most weakly adsorbed one retards the conversion via the magnetic mechanism. The nature of active sites for the reactions is discussed by taking the results of the ESR measurement into consideration. (auth)

7545 STUDIES OF THE BEHAVIOR OF TRIVALENT URANIUM IN AN AQUEOUS SOLUTION. II. ABSORPTION SPECTRA AND ION EXCHANGE BEHAVIOR IN VARIOUS ACID SOLUTIONS. Sato, Akiko; Suzuki, Shin (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 41: 2650-6(Nov. 1968).

The absorption spectra of trivalent uranium in hydrochloric, sulfuric, and perchloric acid solutions were investigated. It was found that there is a possibility of the formation of a chloro-complex from the fact that a large change in absorption spectra was observed at high concentrations of chloride ion. On the basis of these facts, the behavior of trivalent uranium in those media toward ion exchange resin was studied. It was considered that an anionic complex of trivalent uranium begins to form at concentrations of hydrochloric acid above 7 N, which shows good agreement with results obtained on trivalent ions of plutonium, americium, and curium, which are similar actinide elements. However, it was not possible to confirm the existence of a soluble carbonate complex of trivalent uranium, as in the case of trivalent plutonium or americium. (auth)

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Refer also to abstracts 7500 and 8047.

7546 (AI-AEC-Memo-12689) THERMAL COKING CAPSULE EXPERIMENTS ON ORGANIC REACTOR COOLANT. Sullivan, R. J.; Guon, J. (Atomics International, Canoga Park, Calif.). Apr. 26, 1968. 23p. Dep. CFSTI.

The thermal decomposition of irradiated U-3 coolant (Santowax OM) was tested in sealed capsules at 550 and 750°F for periods of 3, 6, and 11 months. Some tests were also made with unirradiated Santowax OM and capsules provided with relief valves. Little effect was observed at 550°F, but at 750°F extensive decomposition occurred leading to nearly complete solidification in six months. Rate constants were estimated for terphenyl disappearance and HB formation. (auth)

7547 (ANL-7484) BUILDUP OF RADIOACTIVE PRODUCTS IN THERMAL REACTORS. I. ^{237}Np TARGETS. Stewart, D. C.; Macias, E. S.; Basile, L. J.; Milsted, J. (Argonne National Lab., Ill.). Sept. 1968. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

Calculations were made of the production of higher nuclides in the irradiation of ^{237}Np in thermal reactors. The data were calculated with a CDC-3600 computer and sheets for the relative yield data are reproduced for seven different flux levels. The yield of ^{238}Pu was essentially constant at lower fluxes, then began to drop between 7×10^{13} and 3×10^{14} n/cm^2-sec and continued to decline sharply at still higher fluxes. (M.C.G.)

7548 (CEA-R-3541) RADIOINDUCED OXIDATION OF n-PARAFFINS FOR OBTAINING BIODEGRADABLE DETERGENTS. Puig, Jean-Rene; Laizier, Jacques; Blin, Marie-Francoise; Marchand, Joseph (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 75p. (In French). Dep.

Oxidation of n-paraffins is a feasible way to obtain biodegradable detergents. This reaction can be radioinitiated and proceed by a branched-chain mechanism, with an induction pseudo-period. A suitable analysis of the reaction is allowed by the semilogarithmic plot of its evolution. The influence of the different parameters of the reaction was studied. Results showed that use of radiation to initiate the reaction is of no economical interest. (auth)

7549 (CONF-681020-(Vol.2), pp 459-71) APPLICATION OF THE REDUCTION-DISTILLATION METHOD FOR PREPARING HIGH-PURITY RARE EARTH ISOTOPE METALS. Kobisk, E. H.; Grisham, W. B. (Oak Ridge National Lab., Tenn.).

Reduction-distillation techniques were developed to provide high-purity rare earth metals in a chemical and physical form, which would be compatible with cold-rolling of ultrathin foils. The method involves high-temperature reduction of rare earth oxides, using a suitable metal reductant, with simultaneous distillation of

the product metal from the reaction matrix. Metal condensates at a purity level of 99.95% (500 ppM total impurity) can be obtained, and the ductility of rare earth metals at this purity permits ultrathin foils (0.00005- to 0.00002-in. thickness) to be prepared. The ability to perform reduction-distillation with only 15 mg of the element (in oxide form) and still maintain collection efficiencies between 75 and 95% made this procedure a valuable and effective method for obtaining most of the rare earth isotopes in elemental form. Foils cold-rolled from these pure materials are applicable for use in precision nuclear cross-section measurements and in solid-state physics experiments. (auth)

7550 (DP-1153) PREPARATION OF $^{238}Pu^{16}O_2$. Porter, John A.; Thompson, Major C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1968. Contract AT(07-2)-1. 19p. Dep. CFSTI.

A process was developed for preparing ^{238}Pu oxide depleted in ^{17}O and ^{18}O and having low neutron emission. The process involves oxygen isotope exchange between $H_2{}^{16}O$ vapor and $^{238}PuO_2$ containing the natural abundance of oxygen isotopes. $^{238}PuO_2$ depleted to about 8% of the natural abundance of ^{18}O emitted only 5.5 n/(sec) (mg ^{238}Pu). (auth)

7551 (ORNL-tr-2062) USE OF AN ADSORPTION METHOD TO PREPARE LOW-CARRIER ^{131m}Xe. Bedrossian, P.; Toth, G.; Zsinka, L. Translated by P. S. Baker (Oak Ridge National Lab., Tenn.), from Isotopenpraxis, 4: No. 3, 117-18(1968). 3p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 45103.

7552 ESR INVESTIGATION OF RADICAL FORMATION IN X-IRRADIATED TIN-ORGANIC COMPOUNDS. Hoeppner, K.; Lassmann, G. (Institut fuer Angewandte Isotopenforschung, Berlin. Institut fuer Biophysik, Berlin). Z. Naturforsch., 23a: 1758-62(Nov. 1968). (In German).

Formation of radicals in tin-organic compounds of the type R_4Sn (R: CH_3, C_2H_5, C_4H_9, Cl, Br) as well as $(CH_3)_3SnCl$ and $(CH_3)_3Sn-SN(CH_3)_3$ irradiated with x rays at 77°K was investigated by ESR. The change of spectra after stepwise annealing of the sample shows that at least two types of radicals are present. In some cases trivalent tin radicals R' $(CH_3)_2Sn$ (R': CH_3 or Sn $(CH_3)_3$) with an unpaired electron localized at the Sn atom with g = 2.02 were detected. A further radical of the type $\equiv Sn-CH_2$ with a tin hyperfine structure of 132 or 160 GauB was identified by the hyperfine structure of the magnetic ^{117}Sn and ^{119}Sn nuclei. A mesomeric stabilized radical in $(C_6H_5)_4Sn$ is unusually stable, as the ESR spectrum did not change from 77°K to 423°K. The yield of radicals in $(C_6H_5)_4Sn$ is smaller by two orders of magnitude than in aliphatic tin-organic compounds. (auth)

7553 CHARGE TRANSFER IN LIQUID-PHASE RADIOLYSIS OF SATURATED HYDROCARBONS. Stone, J. A. (Queen's Univ., Kingston, Ont.). Chem. Commun., No. 24, 1677-8(Dec. 18, 1968).

By the addition of electron scavengers the degree of charge transfer from the molecular ion of a saturated hydrocarbon solvent to an alkane molecule of lower ionization potential is increased. The variation in methane yields when small concentrations of 2,2-dimethylpropane were irradiated in liquid alkanes and cycloalkanes of both higher and lower ionization potentials was examined. Methane yields obtained with cyclopentane as solvent are illustrated graphically, including the increased yields obtained on addition of 2.5 mole % CCl_4 as electron scavenger. SF_6 produced a similar effect. $G(H_2)$ was found to decrease with increasing concentration of scavenger. Results are also illustrated for cyclohexane. The results are discussed and stated to be consistent with a simple charge-transfer mechanism. (UK)

7554 ESR AND ENDOR STUDIES OF ION FORMATION IN X-IRRADIATED THIODIGLYCOLLIC ACID. Box, Harold C.; Freund, Harold G.; Budzinski, Edwin E. (Roswell Park Memorial Inst., Buffalo). Contract AT(30-1)-3558. J. Chem. Phys., 49: 3974-7(Nov. 1, 1968).

Single crystals of thiodiglycollic acid were irradiated at 4.2°K and examined by ESR and electron nuclear double-resonance (ENDOR) spectroscopy. The paramagnetic absorption consists of two components which are attributed to positive and negative ions of thiodiglycollic acid. The negative ion is formed by electron attachment to an oxygen of the carboxyl group. The unpaired spin density is localized primarily on the carbon atom of the carboxyl group. The positive ion has its charge and unpaired spin density localized primarily on the sulfur atom. (auth)

7555 RATES OF POLYMERIZATION OF MONOMERS IN MAPLE AND BIRCH USING A VARIABLE DOSE RATE GAMMA SOURCE. Collins, C. H.; Thomas, C. C. Jr.; Hyche, C. M.; Sondel, J. A. (Western N. Y. Nuclear Research Center, Inc., Buffalo). Forest Prod. J., 17: 52-6(Oct. 1967).

The rate of polymerization and the total dose requirement of ^{60}Co γ radiation of three monomer systems, methyl methacrylate, vinyl acetate, and a 50:50 mixture of styrene and acrylonitrile, were studied using, as woods, both maple and birch. The initial dose rate was varied to observe the effect on the rate of polymerization and the total dose requirement of methyl methacrylate in birch and of accelerated styrene-acrylonitrile in maple. The use of a higher initial dose rate, with the dose rate decreasing after the polymerization was begun, produced wood-plastic combinations with the type of property enhancement that has come to be expected for these composites. The use of a decreasing dose rate source offered certain advantages. One advantage was the obvious savings in the time required to attain the total required dose over the total time required to polymerize either methyl methacrylate or styrene-acrylonitrite with a low constant dose rate source as was recommended for wood-plastic combination production. Another advantage was the lower total dose required for complete polymerization of styrene acrylonitrile and styrene-acrylonitrile/CCl_4 compared to the total dose reported for a constant dose rate source. The great similarity in all handling and processing requirements for the production, with a decreasing dose rate source, of wood-plastic combinations using methyl methacrylate, should encourage further comparisons of the styrene-acrylonitrile systems with their methyl methacrylate counterparts. Tabulated data included a comparison of total dose and time for complete polymerization for a decreasing dose rate source and a constant dose rate source, and the effect of changing initial dose rate with a decreasing dose rate source on the polymerization of monomers in maple and birch. (BBB)

7556 CRYSTAL STRUCTURE EFFECT IN THE γ RADIATION OF p-DICHLOROBENZENE. Milia, F. K.; Hadjoudis, E. K. (Democritos Nuclear Research Center, Athens). J. Phys. Chem., 72: 4707-8(Dec. 1968).

The influence of the crystal structure on the radiosensitivity of p-dichlorobenzene in the triclinic β form, which is stable at about 40°C, and the monoclinic α form, which is stable around 20°C, was studied using γ rays. It was found that the height of the nuclear quadrupole resonance line corresponding to the α form decreased by about 21% and that of the β form by about 10% for the same dose of irradiation. This difference in the radiosensitivity cannot, probably, be due to a temperature effect (since the measurement of the α form at 25°C showed no difference from that at 20°C); hence it can only be attributed to a difference in the crystal structure of the two forms. (D.H.M.)

7557 EFFECTS OF TEMPERATURE AND PRESSURE UPON THE SZILARD-CHALMERS PROCESS IN LIQUID BROMOETHANE. Cole, A. J.; Mia, M. D.; Miller, G. E.; Shaw, P. F. D. (Nuclear Physics Lab., Oxford). Radiochim. Acta, 9: 194-209(Oct. 1968).

The yields of products containing ^{80m}Br from the reaction $^{81}Br(n,2n)^{80m}Br$ in bromoethane-bromine mixtures were investigated for specimens held at atmospheric pressure at −115°C and −80°C, and at 18°C over the pressure range 1 to 10^4 atmospheres. Decrease of specific volume generally leads to an increase in scavenger insensitive yields, while causing diffusive yields to decrease. Individual fractions show marked differences in behavior which cannot be explained only by assuming that diffusion rates are altered. Consideration of modifications to the primary radicals by thermal spikes leads to a simple explanation of the variation in yields of all products where the mechanism of formation is understood. (auth)

7558 UNSTABLE INTERMEDIATES. PART LVII. SOLVATED ELECTRONS: NITROGEN HYPERFINE COUPLING IN THE ELECTRON SPIN RESONANCE SPECTRUM ASSIGNED TO ELECTRONS IN γ-IRRADIATED PYRROLIDINE. Cronenwett, W.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 12, 2991-4(1968).

Various properties, including optical and ESR spectra of glassy pyrrolidine γ-irradiated at 77°K strongly suggest the formation of trapped electrons. The broad ESR feature having a g-value of 2.002 associated with this species was resolved into at least seven bands when the N-deuteriated amine was used; these are assigned to hyperfine interaction with 3 or 4 almost equivalent nitrogen nuclei. (auth) (UK)

7559 INTRAMOLECULAR ELECTROSTATIC ELECTRON TRAPS. Mittal, J. P.; Libby, W. F. (Univ. of California, Los Angeles). Nature (London), 220: 1027-8(Dec. 7, 1968).

It has been found that perfluoro-compounds are an important series of electron acceptors, and that whereas cyclic perfluorocarbons reduce the yield of H_2 gas (produced on electron cation

recombination) from the radiolysis of cyclohexane and n-hexane, the straight chain isomers are ineffective. An hypothesis is suggested for radical anion formation for these compounds, based on the concept of intramolecular electrostatic electron traps consisting of negatively charged F-atoms and positively charged C-atoms. Such traps appear to be 1 or 2 eV deep. In experimental work two different kinds of sources of thermal electrons were employed, ionizing radiation and GM counter discharges. Cyclic and straight perfluorocarbons were ^{60}Co gamma irradiated in a methyltetrahydrofuran glassy matrix at 77°K. In the case of cyclic perfluorocarbons the electron absorption band (λ_{max} at 12,000 Å) was reduced, indicating that these compounds scavenged electrons from the MTHF which were trapped in the glass matrix. With straight chain compounds the trapped electron band was unchanged, indicating that these compounds do not react as efficiently with electrons. The evidence from these and other studies leads to the supposition that only those fluorocarbons that possess an adequately deep well, due to intramolecular geometric electrostatic attractions, capture electrons. The same cyclic and noncyclic compounds were investigated using GM counter tube electrons; it was found that the cyclic fluorocarbons gave multiple counts, whereas the straight chain compounds did not. (UK)

7560 PREPARATION OF SHORT HALF-LIVED RADIOACTIVE GASES FOR MEDICAL STUDIES. Welch, Michael J.; Ter-Pogossian, Michel M. (Washington Univ., St. Louis). Radiat. Res., 36: 580-7(Dec. 1968).

The production of short-lived radioactive gases for medical studies is discussed with regard to the chemical reactions in suggested targets. The chemistry of target materials was studied by using the technique of radiogas–liquid partition chromatography to analyze the product gases. Based on the chemistry of the reactions of ^{15}O in oxygen–nitrogen mixtures, and ^{11}C in boric oxide, targets were designed for the production of ^{15}O-labeled oxygen, ^{15}O-labeled carbon monoxide, and ^{11}C-labeled carbon monoxide in high yields and high radiochemical purity. (auth)

7561 PREPARATION OF AN ^{113m}In GENERATOR. Kawashima, Tatsuro (Government Industrial Research Inst., Nagoya, Japan); Kawamura, Hisahito. Radioisotopes (Tokyo), 17: 569-72 (Dec. 1968). (In Japanese).

An ^{113m}In generator was prepared by elution of SnS_2 precipitated on an anion exchange resin thus utilizing the isotopic exchange reaction between SnS_2 and ^{113}Sn solution. The long-lived parent ^{113}Sn was loaded on the column and the short-lived daughter ^{113m}In was eluted out with 0.1 to 0.01 M HCl. In each milking sequence, the leakage of ^{113}Sn was found to be always of the order from 10^{-3} to 10^{-4}% of the original activity during the passage of 1 l of the effluent through the column. The yield is about 20% of the ^{113m}In on the column. The radiochemical impurities, ^{60}Co and ^{114m}In present in ^{113}Sn sample, are removed by this method. (auth)

7562 SZILARD–CHALMERS PROCESSES IN INORGANIC URANIUM COMPOUNDS. Aten, A. H. W. Jr.; Kapteyn, Johanna C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 9: 223-4(Oct. 1968).

The oxidation of uranium by both the ^{238}U(n,2n)^{237}U and ^{238}U(n,γ)^{239}U reactions in anhydrous and in hydrated uranous sulfate was studied. Annealing increased the retention in the U(IV) state in the normal way. Uranyl compounds produced practically all of the activity in the U(VI) state. The degree of oxidation of U(IV) in the sulfate was quite different for the two nuclear reactions. It was found that the oxidized fraction was largest for the reaction in which the radioactive nucleus was produced with the highest energy, as though this would lead to a higher degree of ionization. (D.H.M.)

7563 RADIATION-INDUCED IONIC POLYMERIZATION OF 1,2 CYCLOHEXENE OXIDE. Cordischi, Dante; Mele, Aldo; Rufo, Roberto (Univ. of Rome). Trans. Faraday Soc., 64: 2794-2801(Oct. 1968).

The radioinduced polymerization of 1,2-cyclohexene oxide was investigated under very dry conditions. The retarding effect caused by addition of water and ammonia on the polymerization rate and on the molecular weight strongly suggests an ionic mechanism. A linear dependence of the polymerization rate and the invariance of the molecular weight with dose rate provide evidence that for pure samples chain termination occurs between propagation ions and traces of impurities which cannot be removed. The results were critically examined with the aim of evaluating the G_i (initiating species) and the ratio (k_t/k_p) between the rate constants for retardation and propagation. (auth) (UK)

7564 CARBONIZATION OR IRRADIATED POLYVINYL CHLORIDE. Walker, P. L.; Kline, D. E. (Pennsylvania State Univ., University Park). Contract AT(30-1)-1710. Carbon, 6: 739-41(Oct. 1968).

PVC samples irradiated with a ^{60}Co source were carbonized in N_2 to investigate the possibility of producing carbons of increased surface area which might exhibit molecular sieve properties. Surface areas were calculated from CO_2 and N_2 isotherms measured at 195 and 77°K, respectively, by means of the BET equation. Irradiation doses up to 6.4×10^8 rad increased carbonization yields, and the surface area of carbons produced increased with dose to a maximum of 8.5 m^2/g. A low N_2 area measurement suggested that the major contribution to the surface area came from pores in the 4 to 5 Å range. (UK)

7565 COST MINIMIZATION IN NEUTRON ACTIVATION ANALYSIS AND ISOTOPE PRODUCTION. Eckoff, N. D. (Kansas State Univ., Manhattan); Fan, L. T.; Kimel, W. R. Nucl. Appl., 6: 16-22(Jan. 1969).

Costs associated with isotope production are minimized using Pontryagin's Maximum Principle. This method is combined with a technique to maximize the amount of a specific radioisotope compared with the total amount of a group of radioisotopes by selecting proper irradiation and decay times. Results of several examples are given. (auth)

7566 STRUCTURE AND PROPERTIES OF POLYETHYLENE PRODUCED BY γ-RADIATION POLYMERIZATION IN FLOW SYSTEM. Machi, S.; Kawakami, W.; Yamaguchi, K.; Hosaki, Y.; Hagiware, M.; Sugo, T. (Japan Atomic Energy Research Inst., Takasaki). J. Appl. Polym. Sci., 12: 2639-47(Dec. 1968).

The radioinduced polymerization of ethylene was carried out by use of a bench-scale plant with a flow-type reactor of 1 liter capacity under the following conditions: pressure, 200 to 400 kg/cm^2; temperature, 30 to 90°C; irradiation intensity, 3.8×10^5 RAD/hr; and ethylene flow rate, 300 to 3000 nl/hr. The molecular weight of polymer formed was shown to decrease with increasing reaction temperature and to increase with increasing pressure. When the ethylene flow rate increases, the molecular weight decreases in the polymerization at 30 to 60°C, but it does not change in the polymerization at 75 to 90°C. Methyl group content, which is a measure of short-chain branching of the polymer, increases with increasing reaction temperature, i.e., ca. 1 CH_3/1000 CH_2 at 30°C and ca. 9 CH_3/1000 CH_2 at 90°C. Methyl content is independent of the ethylene flow rate. The changes in the melt index of polymer with reaction conditions correspond to the change of the molecular weight. The density, crystallinity, and melting point of polymer decrease with the reaction temperature as the short-chain branching increases, and they are almost independent of ethylene flow rate and pressure. (auth)

7567 THE NMR LINE WIDTH IN THE IRRADIATED POLYTETRAFLUOROETHYLENE. Tutiya, Mituaki (Tokyo Metropolitan Inst. for Radiological Research). J. Phys. Soc. Jap., 25: 1518-19(Nov. 1968).

Previous studies indicate increased crystallinity with post-irradiation heat treatment of polytetrafluoroethylene (PTFE). The influence of crystalline regions on molecular motions in the amorphous regions was studied by observing details of NMR line width around the crystalline transition temperature in the γ-irradiated PTFE. (J.G.B.)

7568 VISCOSITY-DEPENDENT ION RECOMBINATION LUMINESCENCE IN ORGANIC LIQUIDS AND SOLIDS FROM ELECTRON AND GAMMA IRRADIATION. Leone, James A.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 49: 5294-310(Dec. 15, 1968). (COO-38-537).

Recombination luminescence of triphenylamine (TPA), both fluorescence and phosphorescence, has been used to investigate ionic processes in: (a) γ-irradiated 3-methylpentane (3MP) at 77°K; (b) thermoluminescence (TL) in γ-irradiated 3MP; and (c) in 1-MeV electron-pulse-irradiated paraffin oil and squalene from 215 to 298°K. The shape of the time-dependent decay of luminescent intensity, I(t), in (a) was independent of a 500-fold change in irradiation dose, providing evidence for substantially complete correlation of geminate charge pairs. Photoionization of TPA under otherwise similar conditions led to the same I(t), which provides evidence that the distribution, P(R), of charge separation produced by γ irradiation is determined by very low-energy electrons. TL curves in part (b) showed two well-defined maxima of intensity I′ attributed to recombination of $TPA^+ - e^-$ at 83°K and I″ attributed to $TPA^+ - TPA^-$ at ~95°K. The ratio I″/I′ increased with the concentration of TPA, I′ decreased with ir bleaching of solvent-trapped e^- or addition of CO_2 while both I′ and I″ decreased with addition of methyltetrahydrofuran, a hole trap. In part (c) intensity I was measured from 10^{-6} to 10^{-3} sec as appropriate at various temperatures and solvent viscosities which ranged from 1 to 10^3P. Excepting Čerenkov radiation, the luminescence spectrum coincides with TPA fluorescence, the phosphorescence intensity being negligible since its half-life is

~2 sec. Linear plots of lnI vs t can be resolved into two exponential decays, with $t_{\frac{1}{2}}$ of the slow component proportional to (viscosity)$^{\frac{1}{2}}$, and attributed to recombination of TPA^+ with TPA^-. The faster component of I is attributed to recombination of TPA^+ with e^-, but $t_{\frac{1}{2}}$ was too short for reliable measurement over most of the range. The dependence $t_{\frac{1}{2}} \propto \eta_{\frac{1}{2}}$ demonstrates the inapplicability of Stokes' law (which requires $t_{\frac{1}{2}} \propto R^3$) to recombination of isolated ion pairs, the high field reducing the randomness of relative ion displacements R. If the probability per ion jump mean free path λ against the central field at R is $P = \exp(-e^2\lambda/\epsilon R^2 kT)$, the net displacement for dN jumps is $dR = [1 - \exp(-e^2\lambda/\epsilon R^2 kT)]\lambda dN$. This leads to $t_{\frac{1}{2}} \propto R^m$ with $1 \leq m \leq 3$. This relation combined with $dn_i/dt = (dn_i/dR)(dR/dt)$ gives the ion pair distribution dn_i/dR. From this expression and an assumed dependence $R^n \propto N$ for free charge one obtains the free-charge distribution function. (auth)

7569 RADIOLYTIC OXIDATION OF SINGLE CRYSTALS OF GRAPHITE BY OXYGEN, CARBON DIOXIDE, AND METHANE + CARBON DIOXIDE MIXTURES. Feates, F. S. (Atomic Energy Research Establishment, Harwell, Eng. Argonne National Lab., Ill.). Trans. Faraday Soc., 64: 3093-9(Nov. 1968).

Oxidation of graphite by radiolyzed CO_2 or O_2 led to the abstraction, by gaseous active species, of individual carbon atoms from basal planes, producing vacancies. Vacancies and edges act as active centers for subsequent oxidation and expanding areas of carbon, 1 atom layer thick, were oxidized by a mechanism involving surface diffusion of oxygen-containing groups. The rate of vacancy formation was similar with O_2 and CO_2, implying that the same species may be involved, but the rate of expansion was much higher with radiolyzed O_2, suggesting different species for this process. In the presence of 1% CH_4, carbon dioxide was incapable of oxidizing graphite, and the graphite surface was modified in such a way that gold ceased to be mobile upon it at temperatures below 700°C. (auth) (UK)

7570 ELECTRON SPIN RESONANCE AND OPTICAL STUDIES OF RADIATION-INDUCED INTERMEDIATES. RADICAL IONS AND RADICALS FROM α-METHYLSTYRENE IN ORGANIC GLASSES. Lin, Jacob; Tsuji, Kozo; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Trans. Faraday Soc., 64: 2896-2906 (Nov. 1968).

Radical ion and radical intermediates derived from α-methylstyrene by gamma irradiation and photoionization in organic glasses were assigned by ESR and optical techniques. Measurements made in rigid solutions of the monomer in 3-methylpentane and methyltetrahydrofuran at −196° indicate that the radical anion is formed by electron capture during irradiation and exhibits absorption bands at 411 and 580 nm. When these glasses are warmed after gamma irradiation the radical anion is converted to the neutral α,α-dimethylbenzyl radical by proton transfer from the positive ion. The latter radical is also observed in ethanol glasses immediately after irradiation, and the hyperfine splitting constants are 16.5 gauss for the 6 methyl protons and 5.5 gauss for the 3 protons (ortho and para) in the aromatic ring. Evidence from isotopic studies indicates that the neutral radical is formed in ethanol by proton transfer from the hydroxylic proton to the vinylidene group of the radical anion. (auth)

7571 γ RADIOLYSIS OF ETHANOL VAPOR. Bansal, K. M.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc., 90: 7183-9(Dec. 18, 1968).

In the γ radiolysis of ethanol vapor, the product yields changed only slightly as the temperature increased from 60 to 200°C. Increasing the ethanol pressure from 45 to 1700 torr at 150°C decreased the yields of hydrogen, acetaldehyde, and ethylene but had no effect on those of methane and carbon monoxide. The changes of yield with pressure were interpreted in terms of excited molecules whose decomposition lifetimes had lower limits of 1.9×10^{-10} and 3.0×10^{-10} sec. The hydrogen and acetaldehyde yields decreased with increasing dose; this was attributed to the scavenging of electrons by acetaldehyde, with the ultimate formation of $(CH_3CHO^-) \cdot nC_2H_5OH$. Propylene scavenged hydrogen atoms and free radicals, but not ions or electrons in this system. The efficiency of scavenging methyl radicals increased with increasing pressure. Sulfur hexafluoride scavenged electrons; some of the resultant intermediates or products caused the yields of acetaldehyde and diethyl ether to increase. Direct formation of molecular hydrogen from ion−electron neutralization in ethanol vapor at 150°C was negligible. Ammonia had no effect on the rates of formation of the ethanol radiolysis products because neutralization of either $(C_2H_5OH)_m H^+$ or $(C_2H_5OH)_m NH_4^+$ by an electron resulted in the formation of a hydrogen atom, and the ultimate products were the same. (auth)

7572 FREE-RADICAL CHAIN REACTIONS IN THE RADIATION-SENSITIZED PYROLYSIS OF ETHANOL VAPOR. Bansal, K. M.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc., 90: 7190-6(Dec. 18, 1968).

The study of pyrolysis reactions can be assisted by use of the radiation-sensitization technique. In this way the over-all kinetics are simplified and information can be obtained about the chain-propagation reactions. At temperatures above 300°C in the radiolysis of ethanol vapor, free-radical chain reactions account for most of the decomposition of ethanol. The mechanisms were tested by the addition of propylene (free-radical scavenger), sulfur hexafluoride (electron scavenger), and ammonia (proton scavenger). Between 300 and 375°C, at pressures in the range 10^2 to 10^3 torr, three modes of decomposition occur to similar extents. The stoichiometric equations are: I, $C_2H_5OH \rightarrow H_2 + CH_3CHO$; II, $C_2H_5OH \rightarrow CH_4 + CH_2O$; III, $C_2H_5OH \rightarrow C_2H_4 + H_2O$. The activation energies, in kcal/mole, and orders of the respective rate-limiting chain propagation reactions at 350°C and 300 to 500 torr are: $CH_3CHOH \rightarrow CH_3CHO + H$, ≥ 30, 1.2; $CH_3CH_2O \rightarrow CH_3 + CH_2O$, 20, 1.9; $CH_2CH_2OH \rightarrow C_2H_4 + OH$, 27, 1.5. These unimolecular reactions are in their pressure-dependent regions under the present experimental conditions. As the temperature of the system is increased, the relative extents of occurrence of the three mechanisms become I > III > II at about 420°C, and the difference between their contributions increases with further increase in temperature. This conclusion also applies to the normal pyrolysis system. Based upon $k(e^- + (C_2H_5OH)_m H^+) = 1 \times 10^{-6}$ cm^3/(ion sec), the value $k(e^- + SF_6) = 3 \times 10^{-12}$ cm^3/(ion sec) was obtained. (auth)

7573 ACTIVE SPECIES IN THE RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE. Ishigaki, I.; Iwai, T.; Hayashi, K. (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part B, 6: 859-63(Dec. 1968).

In a study of γ-induced postpolymerization of trioxane it was found that polymerization can occur after irradiated trioxane is sublimed and crystallized in vacuo. Results indicate that the active species from the radioinduced postpolymerization of trioxane must be stable, held in the crystal lattice of trioxane and not released even at 0°C, and more volatile than trioxane. (D.H.M.)

7574 YIELD OF TRIPLET STATES IN THE PULSE RADIOLYSIS OF AN ALIPHATIC HYDROCARBON GLASS CONTAINING NAPHTHALENE. Land, E. J.; Swallow, A. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Chem. Phys., 49: 5552-3(Dec. 15, 1968).

Studies were made on two mechanisms involved in the formation of triplet states in the radiolysis of 3-methylpentane glass containing naphthalene. A combination of pulse radiolysis and matrix-isolation techniques was used. Air-free solutions of naphthalene in 3-methylpentane glass at 77°K (2×10^{-2} M) were exposed to 5 μsec pulses of 10-MeV electrons from a linear accelerator. The absorption spectrum of the species present immediately after a ~7000 rad pulse was determined point by point. The results are discussed. (P.C.H.)

7575 PHASE CHANGES IN POLYETHYLENE SINGLE CRYSTALS. THE EFFECTS OF THERMAL STRESS AND ELECTRON IRRADIATION. Kiho, H.; Ingram, P. (Research Triangle Inst., Research Triangle Park, N. C.). Makromol. Chem., 118: 45-59(Nov. 19, 1968).

Single crystals of polyethylene were found to undergo a crystallographic phase change from an orthorhombic unit cell to monoclinic when heated to temperatures near their original crystallization temperatures. This change was found to be due purely to thermal stresses set up between the crystals and substrate on which they lie, arising from a difference in expansion coefficients of crystals and substrate. The orientation of the monoclinic lattice with respect to the orthorhombic lattice is consistent with an effective deformation parallel to the orthorhombic primarily through the greatly increased mobility of the chains in their folded portions. The effects of an electron beam on the polyethylene crystal lattice were studied by electron diffraction during irradiation at temperatures from −161 to +110°C. The changes in dimensions of the unit (sub)-cell were determined as functions of the time of irradiation. Above about 30°C a stable hexagonal phase was formed before the crystalline diffraction pattern degraded to a diffuse halo. This change is ascribed to a depression of a transition temperature (due to defects) analogous to that found in n-paraffins when the orthorhombic unit cell becomes hexagonal, and elastic distortions around the lattice defects. It is also noted that the transformation proceeds readily at 110°C in the absence of radiation if a small dose is given initially: the number of defects under these conditions are few and consequently on cooling to room temperature the hexagonal and orthorhombic phase co-exist. Although no definitive conclusions as to the nature of the reaction can be determined, the evidence is that the defects are primarily scissions and cross-links in the crystal lattice. (auth)

7576 CHANGES IN CATALYTIC ACTIVITY AND SURFACE PROPERTIES OF NICKEL OXIDE WITH GAMMA-IRRADIATION. Yamashina, Toshiro; Nagamatsuya, Takaaki; Sano, Masakatsu (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap., 41: 2257-63 (Oct. 1968).

The nature of the active sites of nickel oxide was studied by changing surface properties by means of γ-irradiation technique. Using powdered nickel oxide catalyst, catalytic activities, surface excess oxygen contents, electrical conductivity changes during thermal desorption of gases, and reactivities of the sample with CO_2, CO and H_2 were compared as a function of γ-ray dose of preirradiation. It was found that changes in catalytic activity, the excess oxygen content, and the conductivity change with the increase in the irradiation dose were remarkable when the total dose was greater than 1×10^8 R. The catalytic activity for the decomposition of H_2O_2 was observed to increase, while that for the decomposition of $i\text{-}C_3H_7OH$ vapor was observed to decrease with the irradiation dose. Measurements on the desorption of excess oxygen and the adsorption of CO_2 simultaneously with electrical conductivity have indicated that the adsorbed state of surface oxygen may be changed into a strong form by the irradiation, as $O^-_{(ad)} \rightarrow O^{2-}_{(ad)}$. Correlation between the catalytic sites and surface properties of the irradiated nickel oxide is discussed. (auth)

7577 EFFECTS OF MATRIX POLARITY ON THE OPTICAL AND ELECTRON SPIN RESONANCE SPECTRA OF TRAPPED ELECTRONS IN ORGANIC GLASSES. Ekstrom, Alfred; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 72: 4599-4603(Dec. 1968).

Trapped electrons produced by γ irradiation of 13 organic glasses at 77°K have optical absorption maxima (eV) and ESR line widths which increase smoothly with increasing polarity of the matrix molecules, from 3-methylpentane to glycerol, consistent with a model in which the electrons are trapped in preexisting cavities in the matrix, the size of cavities which stabilize the electrons decreasing with increasing polarity. Trapped electrons in mixtures of alcohols in the glassy state show only one optical absorption maximum. This shifts from the energy characteristic of the first alcohol to that of the second as the mole fraction of the second is increased, indicating that the alcohol molecules are homogeneously mixed, and that each trapping site is composed of several molecules. Trapped electrons in mixtures of normal propanol and 3MP in the glassy state show two electron absorption peaks, one characteristic of each pure species, with preference for trapping in the alcohol phase, indicating aggregation of like molecules. (auth)

7578 EMISSION AND DECAY OF LIQUID-BENZENE AND NAPHTHALENE DERIVATIVES EXCITED BY ELECTRON IMPACT. Christophorou, L. G.; Abu-Zeid, M-E. M.; Carter, J. G. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 49: 3775-82 (Nov. 1, 1968).

Work on the emission from organic liquids excited by electron impact was extended to a large number of liquid-benzene and naphthalene derivatives. In all cases the emission under intense electron impact is characteristic of excimers. A detailed comparison of the spectral characteristics of the electron-impact- and ultraviolet-induced emissions suggests that the emitting species for the organic liquids studied under electron impact are singlet-state excimers, $^1M_2^*$. In six benzene derivatives, in addition to the dominant emission attributed to $^1M_2^*$, a weaker emission band appeared at ~500 nm which may be due to emission from triplet-state excimers, $^3M_2^*$. Measurements were made also of the lifetimes of the emitting species under electron impact. The lifetimes (in nanoseconds) are 12.25 ± 0.2, 15.65 ± 0.2, 8.56 ± 0.1, 12.56 ± 0.2, 8.73 ± 0.1, 11.71 ± 0.14, 11.13 ± 0.24, 11.9 ± 0.3, and 22.86 ± 0.3 for benzene, toluene, ethylbenzene, n-propylbenzene, isopropylbenzene, o-xylene, m-xylene, p-xylene, and mesitylene, respectively, and 68.67 ± 0.2, 25.39 ± 0.1, 48.45 ± 0.36, and 35.4 ± 1 for 1-methylnaphthalene, 2-ethylnaphthalene, 1,2-dimethylnaphthalene, and 1,6-dimethylnaphthalene, respectively. Values for the lifetimes of benzene, toluene, and p-xylene are almost identical with those of $^1M_2^*$ deduced from ultraviolet studies on these systems. This supports the spectroscopic result on the origin of the emission under electron impact and indicates that $^1M_2^*$ is immune to ionization quenching, in contrast to the strong quenching of excited monomers $^1M_1^*$. (auth)

7579 STERIC EFFECT IN THE RADIOLYSIS OF cis- AND trans-1,2-DIMETHYLCYCLOHEXANE. Eberhardt, Manfred K. (Puerto Rico Nuclear Center, Rio Piedras. Technische Hochschule, Munich). J. Phys. Chem., 72: 4509-12(Dec. 1968).

The radiolysis of cis- and trans-1,2-dimethylcyclohexane in the liquid phase was studied from 2×10^{20} to 16×10^{20} eV/ml at a dose rate of 8.3×10^{18} eV/ml hr. The main products are H_2, 1,2-dimethylcyclohexene, 2,3-dimethylcyclohexene, 3,4-dimethylcyclohexene, 4,5-dimethylcyclohexene, octene-2, dimeric products, and isomerization. The trans compound shows a greater decrease in G(olefin) with increasing dose than the cis isomer. Iodine (2×10^{-2} M) reduces $G(H_2)$ in the trans-1,2-dimethylcyclohexane from 3.54 to 2.36 ($\Delta(G(H_2)) = 1.18$) but in the cis isomer the $G(H_2)$ is only reduced from 3.70 to 3.05 ($\Delta(G(H_2)) = 0.65$). Results suggest that the difference of unscavengeable hydrogen between the two isomers, 3.05 – 2.36 = 0.69, is due to molecular hydrogen elimination in the cis-1,2-dimethylcyclohexane and that tertiary axial hydrogens lead preferentially to the formation of scavengeable hydrogen atoms. A similar behavior was observed with cis- and trans-decalin. Evidence for opening and reclosure of the cyclohexane ring is presented. (auth)

7580 QUENCHING OF THE SCINTILLATION FROM A γ-IRRADIATED CYCLOHEXANE SOLUTION CONTAINING p-TERPHENYL BY ELECTRON SCAVENGERS, POSITIVE ION INTERCEPTORS AND SOME HYDROCARBONS. Saito, Tsunenari; Takahashi, Koji; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 41: 2603-8(Nov. 1968).

The luminescence from a cyclohexane solution containing p-terphenyl irradiated with ^{60}Co γ rays was quenched by various compounds. The quenching efficiencies were found to be in the following order; sulfur hexafluoride ~ carbon tetrachloride > nitrous oxide > ethanol > ammonia > carbon dioxide. These compounds are known in radiation chemistry as electron scavengers or as positive-ion interceptors. Cyclopropane and ethylene also showed an appreciable quenching ability, but n-butane showed scarcely any. These results were explained by assuming that ionic reactions are responsible for the luminescence from a cyclohexane-p-terphenyl scintillator. (auth)

7581 RADIATION-INDUCED COPOLYMERIZATION OF ETHYLENE AND SULFUR DIOXIDE IN THE LIQUID AND GAS PHASES. Colombo, P.; Fontana, J.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). J. Polym. Sci., Part A-1, 6: 3201-15(Dec. 1968).

The radioinduced copolymerization of ethylene and sulfur dioxide has been studied in the liquid and gas phases. In the liquid phase, the copolymer composition remained equimolar over a temperature range of 20 to 160°C and ethylene pressures of 50 to 680 atm. The rate of copolymerization in the liquid phase at 680 atm increased with temperature to a maximum value at ~80°C. Above this temperature the rate steadily decreased to zero at 157°C because of temperature-dependent depropagation reactions. In the gas phase, copolymers were formed that contained from 9 to 46 mole-% sulfur dioxide. Under constant conditions of temperature, pressure, and radiation intensity, the copolymerization rate in the gas phase increased with increasing sulfur dioxide in the initial gas mixture. The propagating species for the liquid-phase experiments is considered to consist of an equimolar complex molecule of ethylene and sulfur dioxide. For gas mixtures containing an excess molar concentration of ethylene, the propagating species are ethylene and the complex molecule. Infrared spectra show polysulfone structures. Calorimetric and x-ray diffraction analyses indicate crystalline structures for copolymers in the range 9 to 50 mole-% sulfur dioxide, although a melt transition temperature could not be observed for copolymer containing >31 mole-% sulfur dioxide. Clear uniform film was obtained with copolymers containing up to 31 mole-% SO_2. (auth)

7582 RECONSTITUTION MECHANISMS IN THE RADIOLYSIS OF AQUEOUS BIOCHEMICAL SYSTEMS: INHIBITIVE EFFECTS OF THIOLS. Holian, J.; Garrison, W. M. (Univ. of California, Berkeley). Nature (London), 221: 57(Jan. 4, 1969).

It is stated that while certain classes of organic compounds react quantitatively with both e^-_{aq} and OH (the principal products of the radiolysis of water) in oxygen-free solution, the observed yield for the net destruction of such solutes may be quite low compared with the G-value for water decomposition. For interpreting the radiation chemistry of such systems the concept of a reconstitution or back reaction must be invoked. An example quoted is in the γ radiolysis of oxygen-free solutions of pyrimidine bases, for which reaction mechanisms are presented. It was found that certain labile compounds, such as thiol and cysteine, are effective at low concentrations in blocking the back reaction in these systems by virtue of a H-atom transfer reaction, and the effects of cysteine on the yields for radiolytic reduction of cytosine in oxygen-free solution are given. Ascorbic acid shows a similar inhibiting effect. Other examples are concerned with the radiolysis of primary amides and peptides. The results appear to be interesting in connection with the study of reductive processes involving reactions of e^-_{aq} with unsaturated organic functions both in vitro and in vivo. (UK)

Radiochemistry

Refer also to abstract 7452.

7583 (NP-17716) INTERNATIONAL COMPARISON OF A SOLUTION OF ^{54}Mn. Weiss, H. M. (ed.) (Bureau International des Poids et Mesures, Sevres (France)). Oct. 30, 1968. 41p. (In French). Dep.

In March 1965, the CENS distributed ampoules of a solution of ^{54}Mn to 18 national and international laboratories for an international comparison. The participants were free to apply the methods they preferred. An accidental contamination of the distributed solution by about 2% of ^{35}S gave rise to troubles and loss of accuracy in many of the measurements. The methods applied can be grouped into: x-ray measurements, coincidence measurements and the comparison of the γ-emission rate of the contaminated solution with that of a pure calibrated ^{54}Mn solution. The large spread in the results of the x-ray measurements of about 13% is mainly due to difficulties in the determination of the self- and foil-absorption and in the extrapolation to 100% efficiency. Similarly, rather large deviations also occurred in the coincidence measurements. They are primarily caused by the ^{35}S contamination. In addition, the often applied linear extrapolation to 100% efficiency seems to lead, in the case of a ^{54}Mn solution contaminated by 2% of ^{35}S, to activity values in excess by about 0.4%. In the present case, γ comparison with a pure solution can be considered as the most reliable procedure. The results of this group show a total spread of about 2%. Considering only those values based on a standardization of the pure solution at a time close to the reference time, the spread falls even below 1%. This leads to a "best" value of the specific activity of 884 s^{-1} ng^{-1} on April 1st, 1965, 0 hr 00 UT. From this value and the mean specific x-ray emission rate as obtained by the measurements of the first group, and together with $p_K = 0.900$, a value of $\omega_K = 0.279$ can be deduced for the K fluorescence yield of ^{54}Cr. (auth)

7584 ABSOLUTE DISINTEGRATION RATE OF FINITE GOLD SAMPLE: DETERMINATION BY COINCIDENCE TECHNIQUES. Dooley, John A. (Air Force Flight Dynamics Lab., Wright-Patterson Air Force Base, Ohio). Appl. Spectros., 22: 722-5 (Nov.-Dec. 1968).

A method was developed for absolute disintegration rate determination of finite-sized, radioactive samples. Measurements were made on a 15-mg gold foil. The average disintegration rate was 2.163×10^5 for 24 determinations with a precision of 2.3%. Subsequent measurements yielded precisions as low as 0.5%. Conditions of bias settings, decay corrections, and coincidence resolving times were widely varied. The scintillation, coincidence equipment, including novel pulse timing, is mentioned. Data corrections, including accidentals and particle A in detector B are discussed. It is shown that the corrections are empirical and do not limit the absolute nature of the measurements. Some of the nuclear parameter requirements and spectroscopic implications are indicated. (auth)

Separation Processes

Refer also to abstracts 7465, 7480, 7487, 7761, 7997, 8109, 8661, 9159, 9182, and 9183.

7585 (AERE-R-5024) EXTRACTION OF URANIUM FROM SEA WATER. PART II. EXTRACTION BY ORGANIC AND INORGANIC ABSORBERS. Davies, R. V.; Kennedy, J.; Peckett, J. W. A.; Robinson, B. K.; Streeton, R. J. W. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1965. 52p. Dep. CFSTI. UK.

The organic absorbers that have the highest loading values in seawater are copolymers of formaldehyde and resorcinol arsonic acid (H_2RA_p) with loadings of 1000 to 1100 μg U/g. With inorganic absorbers optimum loadings were attained by certain compounds of lead, basic zinc carbonate (BZC), and hydrated titanium oxide (HTO), which absorbed 200 to 900, 540, and 280 μg U, respectively, per g lead, zinc, and titanium in absorber. The solubility of HTO in seawater is <0.1 μg Ti/ml and is not sufficiently high to render uneconomic its use as an absorber of uranium from seawater. The resorcinol arsonic acid resins (H_2RA_p) lose approximately 2.3% of their initial arsenic per week in contact with seawater while the losses due to solubility of lead absorbers and BZC in the same medium are not less than 0.5 μg lead or zinc per ml. These losses are considered too high for the economic use of H_2RA_p resins, lead compounds, and BZC as absorbers of uranium from seawater. Uranium(VI) and resorcinol arsonic acid monomer (H_2RA_m) form the 1:1 complex UO_2RA_m, and an analogous complex (UO_2RA_p) is formed between uranium(VI) and the functional group RA_p of the resin $H_2R...p$. Carbonate and bicarbonate ions are liberated into solution during the absorption of uranium(VI) from solutions of sodium uranyl tricarbonate, $Na_4UO_2(CO_3)_3$, by BZC and HTO. (auth)

7586 (ANL-7370) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART 13. PILOT-PLANT STUDIES OF THE FLUORINATION OF URANIUM OXIDE WITH BROMINE PENTAFLUORIDE. Holmes, John T.; Koppel, Lowell B.; Saratchandran, N.; Strand, James B.; Ramaswami, D. (Argonne National Lab., Ill.). May 1968. Contract W-31-109-eng-38. 94p. Dep. CFSTI.

Engineering-scale studies were performed in a 3-in.-diam fluid-bed reactor facility to determine the effects of important process variables on the oxidation of crushed UO_2 pellets to U_3O_8 fines in an oxygen–nitrogen stream and the subsequent fluorination of the U_3O_8 with BrF_5 diluted with nitrogen. A fluidized bed of inert alumina served as a heat-transfer medium for the exothermic chemical reactions. The work with BrF_5 consisted of a fractional factorial experiment of eight runs to determine the effects of six process variables on UF_6 production rate, BrF_5 utilization efficiency, and the reaction-rate constant. Crushed UO_2 pellets were oxidized at 450°C using 19.2 vol % oxygen in nitrogen. A larger charge of UO_2 (4.4, rather than 2.2 kg) and finer alumina (–100 nominal mesh, rather than –48, +100 mesh) increased the average oxidation rate slightly. The presence of inactive fission-product compounds did not affect the oxidation rate. In the fluorination of the U_3O_8 fines with BrF_5, the higher temperature (300, rather than 225°C), the higher inlet partial pressure of BrF_5 (~0.29, rather than ~0.16 atm), the greater superficial-gas velocity (0.89, rather than 0.53 ft/sec), and the larger amount of UO_2 charged to the reactor increased the UF_6 production rate. The higher temperature and the greater amount of UO_2 charged to the reactor increased the BrF_5 utilization efficiency. Favorable conditions for the BrF_5 fluorination are: a temperature of 300°C, an inlet BrF_5 partial pressure of 0.29 atm, a fluidizing-gas velocity of 0.89 ft/sec, and a UO_2 charge of 4.4 kg. The use of 48 to 100 or –100 mesh alumina and the presence of fission-product compounds did not significantly affect these results. Although no runs were made at the favorable combination of conditions, the expected average UF_6 production rate and average BrF_5 utilization efficiency for fluorinating the first 50% of the uranium are 185 lb/(hr)(ft^2) of UF_6 and 75%, respectively. These results are considered acceptable for process application. (auth)

7587 (CEA-R-3581) SOLUTIONS TO CRITICALITY PROBLEMS IN A PLUTONIUM EXTRACTION PLANT. Jouannaud, Claude; Rodier, Jean; Fruchard, Yves; Peyresblanques, Henri; Papault, Claude; Tabardel-Brian, Renee (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Aug. 1968. 68p. (In French). Dep.

There are two aspects to nuclear criticality safety: prevention of criticality and protection against the consequences of a possible accident. These two aspects are considered in the case of the Marcoule Plutonium Extraction Plant. After briefly recalling the various techniques used for avoiding criticality (mass, geometry, concentration, poisoning), their application in the plant is described and it is shown that a rational use of a favorable geometry is a factor both for security and from an economic point of view. The system of protection against the consequences of a possible accident, definition of a typical accident, fixing of the boundaries of a critical zone, a safety alarm device, individual and collective dosimetry, an evacuation plan, and safety instructions are discussed. (auth)

7588 (CONF-681020-(Vol.1), pp 373-83) AUGMENTING THE SEPARATION OF ADJACENT PAIRS OF RARE EARTHS IN ELUTIONS WITH HYDROXYETHYLETHYLENEDIAMINETRIACETATE (HEDTA). Powell, J. E.; Burkholder, H. R. (Ames Lab., Iowa).

Rare earth mixtures were eluted with ammonium HEDTA at 92°C with substantial gains in the separation of Er–Ho, Ho–Dy, Dy–Tb, and Tb–Gd pairs. Individual stability constants at 92°C were derived from the observed separation factors, and a simple mechanism was proposed to account for a drastic drop in chelate stability, which occurs when only the lighter rare earth chelate species are heated from 15 to 92°C. A scheme for economical recovery of pure yttrium from yttrium-lanthanide mixtures is discussed. (auth)

7589 (CONF-681020-(Vol.1), pp 385-96) THE USE OF MONO-DI-TRIDECYLORTHOPHOSPHATE IN THE SEPARATION OF YTTRIUM FROM SELECTED LANTHANIDES. Brown, Russell B. Jr.; Gump, J. R. (Central Michigan Univ., Mount Pleasant).

The separation of neodymium from yttrium by liquid-liquid extraction procedures, using mono-di-tridecylorthophosphate as the active organic ingredient is very efficient. However, the separation of terbium, dysprosium, and erbium from yttrium, using the same organic extractant is less efficient as the atomic

number of the lanthanide increases. It is possible to enhance the separation of erbium from yttrium by use of a chelating agent in the aqueous phase. The conditions of separation are presented, including the effect of the concentration of feed in the aqueous solution, concentration of de-emulsifying reagents in the organic phase, the pH of the aqueous phase and others. Separation factors were calculated for the various conditions. (auth)

7590 (CONF-681020-(Vol.1), pp 397-412) CALCULATION OF PERFORMANCE IN THE ION-EXCHANGE SEPARATION OF A MULTICOMPONENT RARE-EARTH MIXTURE. James, D. B. (Nuclear Materials and Equipment Corp., Apollo, Pa.); Helfferich, F. (Shell Development Co., Emeryville, Calif.).

An equilibrium theory is described that provides for the prediction of the behavior of a mixture of any number of rare earths during separation by cation-exchange, displacement development with a complexing eluant. Inputting only the initial composition of the feed mixture and the adjacent binary separation factors, the requisite elution distances, or times, to separate any rare earth from any or all of the others can be calculated. Also the composition of any region of the sorbed mixture can be determined at any point in the development. Two operational modes are considered — initial, uniform, uncomplexed loading and initial chelation prior to loading. (auth)

7591 (CONF-681020-(Vol.1), pp 413-23) DIFFERENTIAL EXTRACTION OF RARE-EARTH ELEMENTS IN QUATERNARY AMMONIUM SALT-CHELATING AGENT SYSTEMS. Bauer, D. J.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center).

Solvent-extraction separation of light-group elements in a quaternary ammonium compound–chelating agent system was successfully demonstrated in single-stage studies. Typical separation factor values obtained are 93 for lanthanum–praseodymium, 5.4 for praseodymium–neodymium, and 11.5 for neodymium–samarium. These results are generally higher than values obtained using organophosphate extractants. Further studies in a 20-stage countercurrent mixer-settler resulted in the production of 99% pure lanthanum at 96% recovery, and subsequently, 92% pure neodymium at 88% recovery. (auth)

7592 (CONF-681020-(Vol.2), pp 439-58) DISTILLATION OF RARE EARTH METALS. Trombe, Felix; Male, Germain (Centre National de la Recherche Scientifique, Bellevue (France). Laboratoire des Terres Rares). (In French).

The separation by distillation of the rare earth metals and the separation of their impurities (metals or nonmetals) were studied. Rare earth metals have equivalent chemical properties, but can show large differences in vapor pressure at a given temperature. Computations indicate that for some of them a complete separation can be realized with one or more distillation. The same is true for the refractory metals tantalum, tungsten, niobium, that the rare earth may contain as a result of their preparation in a crucible made of one of these metals. For halide impurities liquid-vapor concentration differences depend on the metals and halides considered. Halide concentration occurs either in the first part of the distillate or in the residue. For carbon, nitrogen, and oxygen, localization depends on the element. It can be strongly modified by introducing into the product to be distilled elements with an affinity for the nonmetals. Generally experience shows that it is necessary to avoid transport phenomena and mixtures on the condensation surface, which must be renewed taking into account the vapor phase composition. (auth)

7593 (CONF-681020-(Vol.2), pp 751-7) SEPARATION OF RARE EARTHS BY ELECTROLYSIS WITH POROUS CARBON ELECTRODES. Onstott, E. I. (Los Alamos Scientific Lab., N. Mex.).

An electrochemical cell with porous carbon electrodes and flowing electrolyte was utilized to separate Eu(III) from Gd(III) by reduction of Eu(III) to Eu(II) at the cathode and subsequent precipitation as $EuSO_4$ in the flowing catholyte stream. At small concentrations of Eu(II), the $EuSO_4$ could be coprecipitated with $BaSO_4$. A separation method based on mobility differences of Eu(III) and Gd(III) was tested. It was demonstrated that Eu(III) is slightly more mobile than Gd(III), since Eu(III) was preferentially enriched in the catholyte stream. (auth)

7594 (EUR-4075) RECOVERY OF ^{137}Cs USING A MINERAL ION EXCHANGER. Prospert, J.; Lefevre, J.; Raggenbass, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1, 1968. Contract 025-62-10 RISF. 24p. (In French). Dep.

The development of the "PWZr" mineral ion exchanger consisting of a combination of zirconium phosphate and ammonium phosphotungstate has become necessary owing to the high acidity (HNO_3 about 2 M) of the fission products solutions from which ^{137}Ce was to be recovered. Although incomplete as yet, our knowledge of this exchanger suggests that it could conceivably be produced on a semi-industrial scale. The first experiments at this level tally well with the laboratory results, and enable about 200 Ci of ^{137}Cs to be recovered per kilogram of exchanger material. Elution is obtained by 5M ammonium acetate, which is then eliminated by heating in an evaporator until it forms a dry precipitate. The Cs is then recovered by water and can be converted into chloride or incorporated in the form of a pollucite-type silico-aluminate. (auth)

7595 (EUR-4076) FINAL PURIFICATION OF STRONTIUM BY PRECIPITATION. Aubertin, Ch. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1, 1968. Contract 025-62-10 RISF. 20p. (In French). Dep.

The magnesium–strontium separation in ^{90}Sr recovery process was investigated. The impurity composition in the strontium to be purified is the same as might be expected with the extraction process using bis-2-ethylhexyl ester of phosphoric acid. Magnesium–strontium separation was attempted by precipitation of the oxalates, carbonates, oxinates, and hydroxides, the latter giving the best results. It is, therefore, possible to reduce from 100 to 1 the magnesium–strontium mole ratio with a loss equal to or less than 1%. This purification directly precedes the preparation of strontium titanate. (auth)

7596 (JINR-P6-4130) RAPID SEPARATION OF MIXTURES OF SOME ELEMENTS OF GROUPS III–V BY CONDENSATION AND ADSORPTION OF VOLATILE CHLORIDES FROM A GAS STREAM ON TEMPERATURE GRADIENT. Zvarova, T. S.; Chuburkov, Yu. T.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 16p. (In Russian). Dep.

Mixtures of elements (Nb, Ta, Hf, In) were chlorinated at about 450°C in a stream of nitrogen, saturated with thionyl chloride vapors in the presence of carbon. The gas mixture passed through a glass tube with the temperature falling along the gas path. Examples are given of separation of elements in micro- and macroquantities in <30 min. The heat of adsorption for chlorides on the glass surface is estimated for various experimental conditions. (auth)

7597 (K-1759) CONCEPTUAL STUDY OF A FLUORIDE VOLATILITY PLANT FOR REPROCESSING LIGHT WATER REACTOR FUELS. Breton, D. L.; Schappel, R. B.; Merriman, J. R.; Pashley, J. H.; Littlefield, C. C.; Habiger, K. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 24, 1968. Contract W-7405-eng-26. 229p. Dep. CFSTI.

An engineering evaluation was made of a fluoride volatility process for recovery of uranium and plutonium from spent low-enrichment nuclear power reactor fuels. The plant throughput was assumed to be 300 tons of uranium per year, which is the expected processing load required for newly constructed and planned nuclear power reactors for the early part of the 1970s. The study procedure involved the following steps: review and evaluation of experimental data provided by Argonne National Laboratory, Brookhaven National Laboratory, Oak Ridge Gaseous Diffusion Plant, and Oak Ridge National Laboratory; establishment of processing rates and preparation of process flow sheets; conceptual design of the process equipment items, and piping and instrumentation schemes; conceptual design of the process buildings; evaluation of the safety aspects, including analysis of criticality problems, shielding requirements, chemical hazards, and disposal of gaseous, liquid, and solid wastes; sizing of the auxiliary facilities; and preparation of a detailed cost estimate. The flow sheet includes hydrogen chloride decladding, followed by oxidation of the exposed uranium dioxide, uranium fluorination using bromine pentafluoride, and plutonium fluorination using elemental fluorine. These operations are all conducted on a single multipurpose fluid-bed reactor, and two head-end processing lines are provided. Reagent streams are recycled. The facility requirements involve a 46,500 sq ft process building, containing process cells with a total area of 2,650 sq ft; an 8,770 sq ft fuel receipt building; a gas filtration system including a 400-foot tall stack; a 23,000 sq ft utility, maintenance, and fluorine plant building; an 8,000 sq ft warehouse; miscellaneous structures for sanitary water service; sewage disposal, security operations; waste storage areas; and a number of general outside improvements. The estimated capital cost for the conceptual plant is about 26 million dollars without contingency and 33 million dollars with a 25% contingency. With a depreciation charge of 15% per year, the unit capital charge becomes $16.34 per kg of uranium The operating cost is estimated to be $10.98 per kg of uranium; therefore, the total unit processing cost is $27.32 per kg of uranium. (auth)

7598 (ORNL-4309) ULTRAHIGH-VACUUM ZONE PURIFICATION OF ZIRCONIUM WITH ANALYSIS OF PARTIAL PRESSURES. Easton, D. S.; Betterton, J. O. Jr. (Oak Ridge Na-

tional Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 49p. Dep. CFSTI.

An electron-beam zone refiner was developed to produce high-purity zirconium and other refractory metals for use in high-field galvanomagnetic studies. A quadrupole gas analyzer was used to monitor the gas composition over various metals during zoning. Resistance ratios ($R_{300°K}/R_{4.2°K}$) and chemical analysis provided indications of purity levels. Zirconium was successfully zone refined up to 65 zone passes for oxygen removal. The low partial pressures in the system made these lengthy operations possible without contamination. Resistivity ratios of up to 1300 in zirconium and 300 in hafnium were achieved. (auth)

7599 (UJV-1926) EXTRACTION OF NITRIC ACID, URANIUM, PLUTONIUM, AND FISSION PRODUCTS WITH PHOSPHONATES, PHOSPHINATES, AND PHOSPHINE OXIDES. VI. EXTRACTION OF YTTRIUM AND SEPARATION OF URANIUM FROM THIS FISSION PRODUCT. Talas, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1968. 29p. Dep.

The extraction of trace concentrations of yttrium(III) nitrate by dibutyl esters of phosphonic acids of the $(BuO)_2$: PO.R type (where R = methyl, butyl, isoamyl, and phenyl), butyl esters of phosphinic acids of the BuO.PO: R_2 type (where R = methyl, butyl, and isoamyl), and trialkyl phosphine oxides R_3PO (where R = butyl and hexyl) was investigated. The dependence of the extraction of yttrium on the concentration of nitric acid, salting-out agent ($NaNO_3$), and extractant was studied in the presence and absence of uranyl nitrate as well as the dependence on the concentration of uranyl nitrate itself. The extraction of these isotopes from acid-deficient solutions of uranyl nitrate was also studied. The results obtained were also utilized for evaluating the efficiency of the separation of uranium from yttrium. (auth)

7600 (UJV-1927) EXTRACTION OF NITRIC ACID, URANIUM, PLUTONIUM, AND FISSION PRODUCTS WITH PHOSPHONATES, PHOSPHINATES, AND PHOSPHINE OXIDES. VII. EXTRACTION OF STRONTIUM AND SEPARATION OF URANIUM FROM THIS FISSION PRODUCT. Talas, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1968. 25p. Dep.

The extraction of trace concentrations of strontium nitrate by butyl esters of phosphonic and phosphinic acids (of the $(BuO)_2$: PO.R and BuO.PO: R_2 types, respectively, where R = methyl, butyl, and isoamyl) and by trialkyl phosphine oxides R_3PO (where R = butyl and hexyl) was investigated. The dependence of the extraction of strontium on the concentration of nitric acid, salting-out agent ($NaNO_3$), and extractant both in the presence and absence of uranyl nitrate was studied as well as the dependence on the concentration of uranyl nitrate itself. The extraction of strontium from acid-deficient solutions of uranyl nitrate was also studied. The results obtained were utilized for evaluating the efficiency of the separation of uranium from strontium. (auth)

7601 SEPARATION FACTOR FOR THE EXTRACTION SYSTEMS YCl_3-$ErCl_3$-HCl, YCl_3-$HoCl_3$-HCl, AND SOME LANTHANIDE CHLORIDES-HYDROCHLORIC ACID WITH 1 M DI(2-ETHYLHEXYL) PHOSPHORIC ACID IN n-HEPTANE. Gotc, Totaro (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 30: 3305-15(Dec. 1968).

The distribution coefficients of Y, Er, and Ho and the separation factors of some lanthanides with respect to Y are given at macro-concentrations when the lanthanides are extracted by 1.0 M di(2-ethylhexyl) phosphoric acid (D2EHPA) in n-heptane from their chloride solutions. It was found that the separation of Er and Ho from Y is difficult with D2EHPA, but the values of the separation factors of Sm, Gd, Dy, and Yb with regard to Y indicate that removal of these lanthanides from Y is rather easy. (auth) (UK)

7602 TEMPERATURE DEPENDENCE OF THE ISOTOPE EFFECT FOR ELECTROMIGRATION OF POTASSIUM IONS IN MOLTEN POTASSIUM NITRATE. Lunden, Arnold; Ekhed, Alf (Chalmers Inst. of Tech., Goteborg). Z. Naturforsch., 23a: 1779-82(Nov. 1968).

The relative difference ($\Delta b/b$) between electromigration mobilities of ^{39}K and ^{41}K in molten KNO_3 was measured over the range from 354 to 586°C. The mass effect, $\mu = (\Delta b/b)/(\Delta m/m)$, became larger when the temperature was increased, following the relation $-\mu = 0.0385 + 0.000124\,(t - 337)$, where t is the temperature in °C. Due to thermal decomposition, the nitrate is partly converted to nitrite, but it is proved by performing experiments with different initial concentrations of nitrite, that the isotope effect for potassium is not influenced noticeably by the concentration of the anions. The experiment is designed to give an enrichment of the heavy isotope ^{41}K in a small anode compartment and in the upper part of the separation tube. However, it was possible to establish that a slight, but significant, enrichment of the light isotope ^{39}K was obtained in the lower part of the separation tube, i.e., just above the opening into the large cathode compartment. A separation factor of 1.003 was estimated for this enrichment effect, which is due to nonideal conditions of the experiment. (auth)

7603 TEMPERATURE DEPENDENCE OF ISOTOPE THERMOTRANSPORT IN LIQUID METALS. Loewenberg, L.; Norden-Ott, A.; Lodding, A. (Chalmers Univ. of Tech., Goteborg). Z. Naturforsch., 23a: 1771-3(Nov. 1968).

The isotope effect due to temperature gradient was investigated in liquid K and Rb, using steel capillary cells, convenient for the study of the variation of the effect with temperature. The physical parameters, deduced from the experimentally determined steady-state gradient of the isotope separation factor versus reciprocal temperature, agree with earlier results obtained within restricted temperature ranges, and were found to be nearly independent of temperature. (auth)

7604 ON THE PREPARATION OF ^{14}C FROM NEUTRON-IRRADIATED ALUMINUM NITRIDE. Barakat, M. F.; Farag, A. N. (Atomic Energy Establishment, Cairo). Atompraxis, 14: 89-91(Nov.-Dec. 1968).

Carbon-14 was isolated from irradiated aluminum nitride by a simple wet oxidation technique. The optimum conditions of the process were fixed. Results showed that of the total activity initially present about 75 to 80% was isolated by oxidation of carbon-14 into carbon dioxide which was subsequently absorbed in an alkaline solution. Two different techniques were used and were found to be equally efficient and more simple than the acid dissolution technique frequently used for liberating radiocarbon from irradiated nitrides. (auth)

7605 EXTRACTION OF NITRIC ACID AND URANYL NITRATE WITH THE DIHEXYL ESTER OF PHENYLPHOSPHONIC ACID (DHEPPA). Revyakin, V. V.; Chubukov, V. V.; Korableva, N. A. Zh. Neorg. Khim., 13: 3090-95(Nov. 1968). (In Russian).

The distribution coefficients of HNO_3 and microquantities of $UO_2(NO_3)_2$ between aqueous nitric acid solution and DHEPPA solutions in n-decane were measured in a wide interval of concentration of acid and extractant. It was shown that in DHEPPA solvates of the composition $HNO_3 \cdot$ DHEPPA, $(HNO_3)_2 \cdot$ DHEPPA, and $UO_2(NO_3)_2 \cdot 2$DHEPPA were extracted. The concentration distribution constants were calculated for nitric acid as $K_1 = 0.189$ for the mechanism $mH^+_{aq} + mNO^-_{3aq} + DHEPPA_{org} \rightleftharpoons (HNO_3)_m \cdot DHEPPA_{org}$ and $K_1 = 6.68$, $K_2 = 0.193$ for the mechanism $mHNO_{3aq} + DHEPPA \rightleftharpoons (HNO_3)_m \cdot DHEPPA_{org}$. The extraction constant c_x for microquantities of $UO_2(NO_3)_2$ was determined. In the concentration interval of DHEPPA from 0.061 to 1.52 mol (2 to 50 vol %) and acidity of the aqueous phase from 1 to 7 mol $c_x = 3.08 \times 10^5$. The distribution coefficients of HNO_3 and microquantities of $UO_2(NO_3)_2$ were calculated for the values of K_1, K_2, and c_x found. In all cases the calculated data satisfactorily agrees with experimental data with mean deviation of ±6% in the case of HNO_3 and 9.1% in the case of $UO_2(NO_3)_2$. (tr-auth)

7606 EXTRACTIVE SEPARATION OF LANTHANUM, PRASEODYMIUM AND NEODYMIUM WITH CYCLOHEXANONE. Panasenko, E. B.; Belokoskov, V. I.; Ivanova, T. M. pp 76-80 of Kol'skiy Filial. Khimicheskaya Tekhnologiya Redkometal'nogo Syr'ya. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The separation of lanthanum, praseodymium, and neodymium was studied in extraction with cyclohexanone from neutral nitrate solutions with calcium nitrate as the salting-out agent. The partition coefficients and separation factors were determined at different concentrations of the rare earth oxides in the initial aqueous phase and different proportions of the volumes of the organic and aqueous phase. For La and Pr, the separation factor amounts to 2.1, 4.2, and 2.7 at a concentration of rare earth oxides in the aqueous phase of 50 g/liter and ratios of the organic to the aqueous phase of 1:1, 5:1, and 10:1 respectively. Practically no separation of Pr and Nd takes place. (ATD)

7607 STUDY OF THE EXTRACTION OF LANTHANUM, PRASEODYMIUM, AND NEODYMIUM WITH OXYGEN-CONTAINING ORGANIC SOLVENTS. Panasenko, E. B.; Belokoskov, V. I.; Ivanova, T. M. pp 70-6 of Kol'skiy Filial. Khimicheskaya Tekhnologiya Redkometal'nogo Syr'ya. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The distribution of lanthanum, praseodymium, and neodymium nitrates between an aqueous solution and certain alcohols, ketones, and ethers was studied in the extraction from nitric acid and neutral solutions with salting-out agents. Among the extracting agents and systems tested, the highest separation factors were obtained

with cyclohexanone in the presence of calcium nitrate. For La and Pr, the separation factor is 2.6. There is virtually no separation of Pr from Nd. The distribution of the rare earths between an aqueous solution and cyclohexanone in the presence of ammonium thiocyanate was studied in extraction from chloride and nitrate solutions. Of interest are only those nitrate systems with calcium nitrate in which the introduction of NH_4CNS is accompanied by a certain increase of the extraction; the separation factor amounts to 1.2 to 2.2 (ATD)

7608 EXTENSION OF THE TECHNIQUE FOR THE PREPARATION OF ^{14}C FROM NEUTRON-IRRADIATED ALUMINUM NITRIDE. Barakat, M. F.; Farag, A. N. (Atomic Energy Establishment, Cairo). Atompraxis, 14: 491-4(Nov.-Dec. 1968).

A marked lowering in the efficiency of isolation of carbon-14 from neutron-irradiated aluminum nitride was observed when the previously reported wet oxidation method was applied to the treatment of large loads of the irradiated target material. To overcome this, the previously reported flow system technique was basically improved to make possible the treatment of large loads of irradiated aluminum nitride. Results showed that the efficiency of isolation of carbon-14 by the new improved technique was more than 80%. A simple technique is also described for the purification of barium carbonate-^{14}C and also for its transformation into sodium carbonate-^{14}C. (auth)

7609 SEPARATION AND PURIFICATION OF NIOBIUM AND TANTALUM BY EXTRACTION WITH CYCLOHEXANONE FROM SULFURIC ACID SOLUTIONS. Goroshchenko, Ya. G.; Babkin, A. G.; Mayorov, V. G.; Filatova, S. A.; Ude, E. O.; Pyryaev, N. K. pp 48-55 of Kol'skiy Filial. Khimicheskaya Tekhnologiya Redkometal'nogo Syr'ya. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Large-scale tests were carried out in order to check and improve the procedure and apparatus used for extracting and separating niobium and tantalum from sulfate–fluoride solutions by means of cyclohexanone containing hydrofluoric acid. The starting solution supplying the extractor was prepared artificially and had the following composition (g/liter): Nb_2O_5 11 to 12, Ta_2O_5 0.8 to 1.0, TiO_2 3.0 to 6.0, rare earth oxides 0.1 to 0.2, H_2SO_4 350 to 400, $(NH_4)_2SO_4$ 180 to 200. Niobium and tantalum pentoxides containing the following amounts of impurities (in %) were obtained: in Nb_2O_5–0.25 Ta_2O_5, 0.06 SiO_2, 0.01 TiO_2, 0.01 Fe_2O_3; in Ta_2O_5–0.5 Nb_2O_5, 0.025 TiO_2, 0.03 SiO_2, 0.18 Fe_2O_3. Analysis of the experimental data showed that the extraction of niobium from solution amounts to 97 to 97.5%, and that of tantalum, to 95 to 96%. (ATD)

7610 REGENERATION OF CYCLOHEXANONE DURING EXTRACTIVE SEPARATION OF NIOBIUM AND TANTALUM. Goroshchenko, Ya. G.; Mayorov, V. G.; Filatova, S. A. pp 60-2 of Kol'skiy Filial. Khimicheskaya Tekhnologiya Redkometal'nogo Syr'ya. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

In processing rare earth titanoniobates with sulfuric acid, the separation of niobium and tantalum is accomplished by extraction with cyclohexanone (CH), whose losses are due mainly to its solubility in the spent solutions. It was found that CH can be regenerated by extraction with kerosene and reextraction with acids from the kerosene solution. On the basis of the study, the following procedure for regenerating CH is proposed. After the extraction of niobium and tantalum, the spent solution is subjected to extraction with kerosene. The extraction is carried out in two steps at a 1:10 ratio of organic to aqueous phase, 70 to 75% CH being extracted in one step. From its solution in kerosene, CH is extracted with the initial sulfuric acid solution from which niobium and tantalum are to be removed. Since the volumes of the spent and original solution are in the proportion of 10:6, the reextraction is carried out at 1:6 ratio of organic to aqueous phase; this involves 4 steps, in each of which 60 to 65% CH is reextracted. The overall degree of regeneration amounts to 80 to 90%. (ATD)

7611 BACTERIAL LEACHING OF URANIUM. MacGregor, R. A. (Stanrock Uranium Mines, Ltd., Elliot Lake, Ont.). Nucl. Appl., 6: 68-72(Jan. 1969).

Bacterial leaching of uranium ores in the Elliot Lake area has been used as a production method since 1962. Minor amounts were recovered from mine waters prior to this. Uranium in a pyritized quartz pebble conglomerate is oxidized from the tetravalent to the hexavalent state in the presence of bacteria. The bacteria are naturally occurring autotrophs of the Ferrobacillus-Thiobacillus group. The solubilized uranium is then dissolved with water or acid solution and pumped to surface for treatment. Recovery of ammonium diuranate from the resulting acid mine water is carried out in a conventional uranium ion exchange plant. The method produces uranium at low cost from abandoned or caved mine workings. Recovery of thorium and rare-earths by the same method is limited only by market conditions. (auth)

7612 CONTRIBUTION TO THE SEPARATION OF RARE EARTHS BY EXTRACTION CHROMATOGRAPHY WITH DI(2-ETHYLHEXYL) PHOSPHORIC ACID (HDEHP). I. SILICA GEL AS A SUPPORT MATERIAL FOR THE STATIONARY PHASE. Herrmann, Eckhard (Technische Univ., Dresden). J. Chromatogr., 38: 498-507(Dec. 17, 1968). (In German).

Hydrophobised silica gel was used as support material for extraction chromatographic separations of rare earths with di(2-ethylhexyl) ester of phosphoric acid (HDEHP). Columns with a capacity of 0.8 mequiv. per ml of column and a "height equivalent of one theoretical plate" of $H \leq 0.1$ mm for europium and gadolinium were obtained. H is independent of the type of silica gel when its mean pore diameter is ≥35 Å, and is also nearly independent of the amount of HDEHP used, as long as the silica gel only absorbs the dialkyl ester of phosphoric acid so that a dry powder is produced again after absorption. Examples of separation show the efficiency of the columns obtained. (auth)

7613 GAS CHROMATOGRAPHIC SEPARATION OF PAIRS OF ISOTOPIC MOLECULES BY MEANS OF POROUS POLYMER BEADS. Possanzini, M.; Pela, A.; Liberti, A.; Cartoni, G. P. (Univ., Rome). J. Chromatogr., 38: 492-7(Dec. 17, 1968).

The separation of various isotopic molecules with deuterium substitutions is reported. Columns with porous polymer beads (Porapak Q) are employed. A comparison is made between this packing material and other adsorbents, as graphitized carbon black or silica gel. High separation factors are obtained. The working temperatures are usually higher with respect to the other materials, but the isotopic effects measured with the Porapak are more favorable for many of these separations. (auth)

7614 SEPARATION OF RARE EARTH NITRATES BY EXTRACTION WITH TRIBUTYL PHOSPHATE. Eremin, G. K. pp 80-90 of Kol'skiy Filial. Khimicheskaya Tekhnologiya Redkometal'nogo Syr'ya. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The extraction of rare earth nitrates with tributyl phosphate (TBP) from solutions containing neutral salting-out agents was studied, and the effectiveness of separation of cerium rare earths under these conditions was determined. Lithium nitrate was found to be the most effective salting-out agent: the separation factor of the Pr–Nd pair reaches 1.9. It was observed that in extraction with TBP of a nitric acid solution containing lithium nitrate, nitric acid behaves as do rare earth nitrates. In the joint extraction of nitric acid and neodymium nitrate from a solution 6 M in $LiNO_3$, nitric acid is close in extractability to neodymium; this justifies its use as a countersalting-out agent for cerium rare earths. Dilution of TBP with a neutral solvent increases the separation factor of HNO_3–$Nd(NO_3)_3$ in accordance with the square law. It is shown that in the countersalting-out of $Nd(NO_3)_3$ with HNO_3, 1 g-eq of the latter displaces 1 g-eq of $Nd(NO_3)_3$ from TBP. The mechanism of the action of HNO_3 in the extraction of rare earths with TBP is discussed. The dual role of HNO_3 as salting-out agent in the aqueous phase and at the same time a countersalting-out agent in the organic phase is emphasized. The overall effect depends on the HNO_3 concentration and the presence of other salting-out agents. It is concluded that the main conditions for an effective separation of the rare earths in extraction with TBP are a coordination saturation of TBP and the use of a strong salting-out agent. (ATD)

7615 SEPARATION PROCESS OF URANIUM FROM IRON, THORIUM, AND RARE EARTHS BY ION EXCAHNGE RESIN. Sherief, Mohamed K. Saad El-Din; Almasy, Andor U. S. Patent 3,410,667. Nov. 12, 1968. Filed Oct. 29, 1965.

A process is described for recovering uranium in pure form from a contaminated uranium containing a high ferric ion content relative to the uranyl ion content by treating the contaminated uranium with a hydrochloric acid solution and thereafter saturating the acidified solution with SO_2 to reduce the ferric ion content and finally effecting the separation of uranyl ions by means of an anion exchange resin. (auth)

7616 EXTRACTION OF URANYL CHLORIDE AND SULPHATE BY MEANS OF TRI-ISO-OCTYLAMINE. Vieux, Aliette S. (Univ. Lovanium de Kinshasa, Congo). Bull. Soc. Chim. Fr., No. 10: 4281-9(Oct. 1968). (In French).

In order to study the extraction of uranyl chloride and sulfate by means of triisooctylamine dissolved in various solvents (CCl_4, C_6H_6, and xylene), the equilibrium between the aqueous acid solutions (HCl and H_2SO_4) and the amine was investigated. It was found that the extraction of the sulfate amine salt is easier than that of

the chloride amine salt, and that the equilibrium constant of the salts thus formed is a function of the solvent in which the amine was dissolved. Extraction of uranyl chloride and sulfate depends on the acidity. Formulas of the complexes formed were established and the equilibrium constants determined. It appears that the sulfate uranyl amine complex is more stable than the chloride complex. With respect to the influence of the solvent, the most stable complexes are formed with the amine solution dissolved in benzene, followed by xylene, and CCl_4. (auth)

7617 COLLECTION OF URANIUM IN SEA-WATER. I. COPRECIPITATION OF URANIUM IN SEA-WATER WITH METAL HYDROXIDE. Ogata, Noboru. Nippon Genshiryoku Gakkaishi, 10: 672-8(1968). (In Japanese).

With the view to studying the possibility of separating uranium from seawater by coprecipitation, the carrier properties of ferric, aluminium, and titanium hydroxides were examined, with the following results: (1) The values of pH at which uranium started to coprecipitate with the carriers were 4.5 for ferric hydroxide, 5.0 for aluminium hydroxide and 2.8 for titanium hydroxide. (2) Optimum pH values for decarbonated seawater to obtain maximum recovery of uranium were 8 to 9 for aluminium and ferric hydroxides, and 4.5 to 9 for titanium hydroxide with natural seawater, the values were appreciably lower for ferric and aluminium hydroxides, but unchanged for titanium hydroxide. (3) In the case of ferric and aluminium hydroxides, the coprecipitation ratios of uranium were much smaller in natural than in decarbonated seawater. With titanium hydroxide, however, uranium coprecipitated with equal ease in natural seawater as in decarbonated seawater. (4) Uranium was effectively separated from the carriers by carbonate salt extraction but not by acid extraction. (auth)

7618 SOLVENT EXTRACTION SEPARATION OF TANTALUM AND NIOBIUM FLUORIDES WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. Erskine, J. S.; Sink, M. L.; Varga, L. P. (Oklahoma State Univ., Stillwater). Anal. Chem., 41: 70-3(Jan. 1969).

The solvent extraction behavior of trace and millimolar concentrations of aqueous tantalum and niobium fluorocomplexes with N-benzoyl-N-phenylhydroxylamine (BPHA) in chloroform was studied as a function of fluoride and perchloric acid concentrations using radioactive tracer techniques. Least squares curve-fitting calculations on the distribution data indicated that the principal extracting species were $TaF_3 \cdot 2BPA$ and $H_2NbF_6 \cdot 2BPA$ with extraction equilibrium constants 2.0×10^{18} and 3.0×10^{7}, respectively. Single stage decontamination factors up to 70 were achieved from 1.0×10^{-3} molar excess fluoride ion concentrations in the absence of perchlorate on the extraction of millimolar concentrations of both metals into 2.5×10^{-2} molar BPHA in chloroform. (auth)

7619 EXTRACTION OF RARE EARTHS WITH TRIBUTYL PHOSPHATE. Genow, L.; Sachariewa, M. (Chemisch-Technologische Instituts, Sofia). Monatsh. Chem., 99: 1976-81(Sept.-Oct. 1968). (In German).

The extraction of $Gd(NO_3)_3$ and $Yb(NO_3)_3$ with tributyl phosphate (TBP) was studied in dependence on the nitrate ion concentration. The metal nitrate ion complex stability constants in aqueous solution were determined. From the ir spectra of $Ce(NO_3)_3 \cdot 3$ TBP, $Pr(NO_3)_3 \cdot 3$ TBP, $Gd(NO_3)_3 \cdot 3$ TBP, $Yb(NO_3)_3 \cdot 3$ TBP, and $Lu(NO_3)_3 \cdot 3$ TBP a decrease of the strength of the metal-phosphoryl oxygen bond with increasing atomic number was deduced. Comparison of the results of complex formation in aqueous solution with those of complex stability in organic solution provides a possibility to explain the maximum in the distribution coefficient/atomic number curve found at low acidities. (auth)

7620 THE ACTIVITIES OF LA HAGUE CENTER. Boussard, Roger R.; Delange, Maurice; Chambon, Marcel (CEA, The Hague). Ind. At., 12: No. 9-10, 47-56(1968). (In French).

The Hague Centre, which is basically engaged in the large-scale processing of fuels irradiated in the power reactors of the Electricité de France, is described. This UP-2 group began operations early in 1967. Fed the normal fuel (alloy of natural metal uranium and of molybdenum sheathed in magnesium–zirconium), it produces the metal plutonium. By 1969, it will be in a position to produce sealed sources of cesium-137 derived from fissionable products. A running account is given of the difficulties arising and how they have been solved during the two years of operations. Besides the UP-2 group, the Centre has recently installed a pilot AT-1 workshop for treating the UO_2–PuO_2 fuel derived from Rapsodie. This unit will treat its first reactor core by the end of 1968. The industrial aspect of the Centre is enhanced by a number of pilot units and laboratories for applied research. (auth)

7621 TWO YEARS OF OPERATION OF THE EUROCHEMICAL PLANT. Detilleux, Emile (Eurochemic, Mol, Belgium). Ind. At., 12: No. 9-10, 57-63(1968). (In French).

The history of the Eurochemic Company is summarized. Results of two years' experience in running the plant at Mol, which was inaugurated on July 7th, 1966, are analyzed. Special care is given to the various problems which had to be solved, in particular to those pertaining to the decladding, dissolution, and extraction operation. Eurochemic's role in training European reprocessing specialists and publishing technical information is also mentioned. (auth)

7622 THE SEPARATION OF THE CERIUM-GROUP RARE EARTH ELEMENTS BY ION EXCHANGE USING A CITRATE–ACETATE MIXED SOLUTION AS ELUTING AGENT. Shibata, Muraji; Tanabe, Isao; Okuda, Kinnosuke; Kadota, Kazuo (Azuma Kako Co., Takaoka, Japan). Bull. Chem. Soc. Jap., 41: 2627-31 (Nov. 1968).

The separation of rare earth elements by ion exchange was studied. The new eluting agent consists of an aqueous solution of diammonium hydrogencitrate and an aqueous ammonia–acetic acid mixture; the two solutions were mixed in definite ratios. Using a column of Dowex 50 W resin, the separation of Sm, Nd, Pr, Ce, and La was successfully achieved. As practical samples, mixed chlorides obtained from monazite concentrates were used. Both the purities and the yields of the recovered rare earths were greater than 99%. This eluting agent was applied to the separation of yttrium-group rare earths such as Dy, Er, Yb, and Y, but the attempt was not successful. (auth)

7623 CONTINUOUS EXTRACTION WITH ETHYL ETHER IN THE ANALYSIS OF TECHNICAL IRON. Vecera, Z.; Bieber, B. (State Inst. for Research of Materials, Brno). Hutn. Listy, 22: 566-9(1967). (In Czech.).

An apparatus is described for continuous liquid–liquid extraction of Fe from HCl medium. With a 1-g sample, about 99.99% of the Fe can be separated from the impurity elements within 3 hr. The operation of the apparatus was tested in the determination of Al, Bi, Pb, Mg, Zr, and Ti in technical iron. (Anal. Abstr.)

7624 METHODS OF ISOTOPE SEPARATION. I. PHOTOCHEMICAL SEPARATION OF ISOTOPES. Morand, J. P.; Wacongne, M.; Roth, E. (CEN, Saclay, France). Energ. Nucl. (Paris), 10: 362-6(Oct. 1968). (In French).

A photochemical process for the separation of isotopes is possible in certain cases. After a study of the conditions required for such a separation, the particular case of selective oxidation of mercury isotopes by oxygen in the presence of butadiene and by ultraviolet irradiation at a wavelength of 2537 Å was considered. The set of reactions leading to the formation of enriched mercuric oxide is presented. The practical conditions for separation of the isotopes 202 and 196 of mercury were studied. (auth)

7625 METHODS OF ISOTOPE SEPARATION. II. DEUTERIUM SEPARATION BY CONTINUOUS COLUMNS USING H_2–H_2O ISOTOPIC EXCHANGE. Mercea, Victor (Institut de Physique Atomique, Cluj). Energ. Nucl. (Paris), 10: 367-75 (Oct. 1968). (In French).

Although the isotopic equilibrium separation factor of the H_2–H_2O system is among the highest known, this system, after having been used for an industrial production of heavy water, has been abandoned for a primary plant in favor of others more economically attractive. But there are fields in which the high enrichment possibilities of this process can be of value, especially where moderate quantities of material are involved. This situation occurs at least in two cases: for the final enrichment in a primary heavy water plant and for tritium or protonium depletion of the heavy water in reactors. A solution to the problem of water-hydrogen countercurrent is provided by maintaining the high gas-phase activity of the catalyst. An improvement of the nickel–chromium oxide catalyst, which makes it highly suitable for this purpose, is described. (auth)

7626 METHODS OF ISOTOPE SEPARATION. III. SEPARATION OF URANIUM ISOTOPES ON ION EXCHANGERS. Ciric, Milan. Energ. Nucl. (Paris), 10: 376-80 (Oct. 1968). (In French).

The isotope separation effects in the ion-exchange equilibria were studied in the systems containing aqueous solutions of uranyl salts and a cation exchanger of the Dowex 50 type. ^{235}U is enriched in the resin phase; the separation factor, determined by the breakthrough method, varies from 1.0000 to 1.00006. In order to obtain higher separation effects, band displacement experiments were also made. The method is convenient for production of macroquantities of 1 to 2% ^{235}U. Isotopic analysis was carried out on a mass spectrometer by a surface-ionization method. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 7640, 7656, 7769, and 7883.

7627 (COO–414-8) DETAILED CHARACTERIZATION OF SOIL AND VEGETATION ON SELECTED SITES TO SERVE AS BASIS FOR FUTURE EVALUATION OF EFFECT OF RADIOACTIVE CONTAMINATION. Technical Progress Report, March 1, 1968–November 26, 1968. Haghiri, F. (Ohio Agricultural Research and Development Center, Wooster). Nov. 26, 1968. Contract AT(11-1)-414. 111p. Dep. CFSTI.

Runoff water, leachate water and plant samples from field micro-plots were assayed for ^{90}Sr and stable Ca. The removal of ^{90}Sr by the above materials as influenced by cropping systems and soil management practices is presented. Over a six year period the percent ^{90}Sr activities in runoff water from micro-plots decreased while the activities in leachate water increased with time. High rates of lime increased the yield of corn fodder and grain and decreased the ^{90}Sr uptake by corn. Over a six year period total ^{90}Sr removed from plots treated with ^{90}Sr was 14.683, 12.305, 11.294, 10.073 and 7.328% for gravel mulch, rotation "a," continuous corn, rotation "b" and permanent grass, respectively. The activities of ^{90}Sr in the leachate obtained from ^{90}Sr treated soils were not different from ^{90}Sr plus paraquat treated soils. Similar results were obtained for ^{137}Cs. The ineffectiveness of paraquat appears to be due to the low amount of applied paraquat. The relationship between the levels of paraquat applied to various soil types and ^{90}Sr adsorption by soils was studied. In general, the percent ^{90}Sr not adsorbed by soil increased with increasing level of added paraquat. The percent ^{90}Sr not adsorbed by soil was negatively correlated with % organic matter, % clay, pH and Mg contents of soil. Small quantities of ^{90}Sr were detected in the leachates of the soil columns incubated with plant tissue containing ^{90}Sr. The largest quantities of ^{90}Sr in the leachates were from the Wooster soil and from the corn tissue. In the leachate of the Muck soil samples, ^{90}Sr was detected only from the soybean treatment. For the Plainfield sand, ^{90}Sr was detected only from the corn treatment. Drying (at 105°C) the soil samples after the adsorption of Sr increased the quantities of water soluble Sr. The liquid phase also had more color, suggesting a higher concentration of organic compounds. These soil samples were extracted with water solutions of various organic compounds. Phytic acid was the most efficient extractor of Sr from the soil samples. Glucuronic acid and citric acid were next best and dextrose was the poorest. Pectic acid, glycine and pyrocatechnol were intermediate. (auth)

7628 (MIT–1381-16) VARIATIONS IN ISOTOPIC ABUNDANCES OF STRONTIUM, CALCIUM, AND ARGON AND RELATED TOPICS. Sixteenth Annual Progress Report, 1968. (Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics). Dec. 1, 1968. Contract AT(30-1)-1381. 159p. Dep. CFSTI.

The results of radiometric age data on two-thirds of the continental area of the earth are presented, and the significance of these data to the continental drift theory examined. The data were obtained mainly by the argon/potassium method. The Rb and Sr isotopic compositions of Canadian gangue minerals and syenitic rocks were analyzed and it was concluded that the strontium isotopic composition of the gangue minerals largely reflects the compositions of the host rocks at the time of mineralization. Age estimates based on the $^{86}Sr/^{87}Sr$ and Rb/Sr ratios were made for Ontario gold quartz and syenites, and Quebec rhyolite and sulfide ores. The $^{86}Sr/^{87}Sr$ ratios of charnockites and granitic rocks from the Adirondacks, Ontario, Uganda, Tanzania, and India were determined. An age of about 3000 m.y. was estimated for the Imacata Series, Venezuela. Rb–Sr analyses of Brazilian rocks are continuing. The results of age estimations and isotopic analyses of rocks, mainly gneisses, from Colombia, British Honduras, Gabon, Liberia, Venezuela, and Sierra Leone, and of Canadian Huronian sediments, Connecticut pegmatite, and Massachusetts rhyolites are given. Reprints of papers on K, Rb, and Sr distribution on the earth, the Continental Drift Theory, and the age of Canadian and South American rocks, as well as abstracts of papers presented at the Geological Society of America meetings of 1967 and 1968, are included. (L.C.L.)

7629 (PNE–3012(Vol.2)) STATISTICAL ANNEX OF THE CONOMETRIC STUDY OF SMALL AND INTERMEDIATE SIZE DIAMETER DRILLING COST FOR THE UNITED STATES. (Mathematica, Princeton, N. J.). [nd]. Contract AT(04-3)-744. 385p. Dep. CFSTI.

Small and intermediate size diameter drilling costs are investigated for various states. Then costs are investigated for three geological regions and costs for various soil textures are tabulated. (J.C.W.)

7630 CHLORINE LOGGING METHODS. Tittman, Jay (to Schlumberger Tech. Corp.). U. S. Patent 3,413,471. Nov. 26, 1968. Filed Aug. 28, 1962.

A method of determining the characteristics of earth formations traversed by a well consists of irradiating the formations with bursts of fast neutrons. Prompt gamma rays resulting from thermal neutron capture interactions with chlorine nuclei in the formations are detected only during the first relatively short time intervals following the slowing down of the neutrons to thermal energy after the bursts. Prompt gamma rays resulting from thermal neutron capture interactions with hydrogen nuclei in the formations are detected during second relatively long time intervals extending beyond the first time intervals and intermediate successive neutron bursts. Indications are recorded that vary as a function of the capture gamma rays from chlorine and from hydrogen detected in the respective time intervals. (Offic. Gaz.)

7631 LOGGING SYSTEM AND METHOD FOR IDENTIFYING ANHYDRITES. Caldwell, Richard L. (to Mobil Oil Corp.). U. S. Patent 3,413,472. Nov. 26, 1968. Filed Aug. 28, 1964.

Sulfurous formations are distinguished from porous formations containing hydrogenous fluid by irradiating the formation with fast neutrons and measuring the returning count rate of the neutrons and 5.43 MeV gamma rays. Measurements indicating the presence of sulfur and hydrogen in the formation indicate an anhydrite formation. (Offic. Gaz.)

7632 DETECTION OF ^{39}Ar IN ATMOSPHERIC ARGON. Loosli, H. H.; Oeschger, H. (Univ., Bern). Earth Planet Sci. Lett., 5: 191-8(Nov. 1968).

With an extremely sensitive proportional gas counting technique the ^{39}Ar-activity in atmospheric argon has been measured for the first time by comparison of recent atmospheric argon with argon originating from ^{40}K-decay in well gas. From the first two measurements an activity of 0.121 ± 0.005 dpm/lt argon was obtained, whereas a second set of measurements showed a lower value of 0.084 ± 0.004 dpm/l argon. The discrepancy possibly is due to a contamination of the well gas argon. From measurements of argon samples collected in 1940 and 1959 to 1967 it can be concluded that the bomb test contribution to the atmospheric ^{39}Ar-activity is less than 0.005 dpm/l argon. Possible applications of this isotope as a tracer especially in oceanography and glaciology for problems covering a time range of 100 to 1000 years are discussed. The production rate of ^{39}Ar in the atmosphere is estimated. (auth)

7633 LEAD ISOTOPE COMPOSITIONS AND URANIUM DECAY SERIES DISEQUILIBRIUM IN RECENT VOLCANIC ROCKS. Oversby, V. M.; Gast, P. W. (Columbia Univ., Palisades, N. Y.) Earth Planet Sci. Lett., 5: 199-206(Nov. 1968).

Concentrations of uranium, thorium, radium, total lead, lead-210 and lead isotopic composition are given for recent volcanic rocks from Tristan da Cunha, Faial, Azores and Mt. Vesuvius. Disequilibrium observed among uranium daughter products is interpreted in terms of chemical fractionations occurring during magmatic processes. In all cases, the fractionation pattern Ra > Th > U was observed. The fractionation indicated by the $^{230}Th/^{238}U$ ratio implies that removal of liquids from mantle sources lowers the Th/U ratio of the source region. This is consistent with the fractionation postulated to explain observed lead isotopic compositions in many oceanic volcanic provinces. The U–Pb fractionation pattern is more difficult to interpret than the Th–U and Ra–U fractionations. (auth)

7634 METHOD OF DETERMINING DIRECTION AND VELOCITIES OF FLUID FLOW INTO A WELL BY MEANS OF RADIOACTIVE TRACER INTRODUCTION INTO THE WELL. Young, Marcus C. (to Cardinal Surveys Co. Well Reconnaissance, Inc.). U. S. Patent 3,406,284. Oct. 15, 1968. Filed Aug. 19, 1964.

A method for investigating water flow in a well and into the earth formations penetrated by the well is described. The water is introduced at a constant rate for a predetermined period of time to cause stabilization of the water flow into the earth formations during the investigation. A detector is located in the well above the expected locations of the flow into the formations. A quantity of tracer material is introduced into the well a predetermined distance above the detector. The period of time required for the tracer material to pass the detector is deter-

mined. The detector is moved in the well through the tracer material as it moves downward in the well to determine locations of outward flow of the tracer material through the well. (Offic. Gaz.)

7635 DISTRIBUTION OF ^{90}Sr IN THE MEADOW-STEPPE ZONE SOILS. Novikova, S. K.; Tyuryukanova, E. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Pochvovedenie, No. 12, 46-52(Dec. 1968). (In Russian).

A higher content and a more uniform distribution of ^{90}Sr were observed in the chernozem soils of the meadow-steppe zone as compared with the south taiga zone. A maximum radioactive strontium content was found in upper horizons of chernozem soils and in calcareous horizons of calcareous chernozems. Strontium-90 penetrates as deep as 100 cm. A seasonal migration of ^{90}Sr is observed in the profile of chernozems. (auth)

7636 EXPERIENCE FROM LARGE DISCHARGES OF RADIOACTIVE LIQUID WASTE. Schwibach, J. Atomkernenergie, 14: 65-8(Jan.-Feb. 1969). (In German).

The investigations of large discharges of radioactive liquid wastes into the Columbia and Clinch Rivers have revealed the possible consequences of releasing radioactive substances into the environment. They showed which processes in the environment determine that dose limits for the public are not exceeded. Twenty years of experience with discharges of some 100,000 Ci annually into the Columbia River and on the average 700 Ci annually into the Clinch River allow us to safely assess the possible consequences of large discharges to man. (auth)

Meteorology

Refer also to abstracts 7995 and 8004.

7637 (COO-1199-17) STUDY OF RAINOUT OF RADIOACTIVITY IN ILLINOIS. Seventh Progress Report. (Illinois State Water Survey, Urbana). Nov. 1968. Contract AT(11-1)-1199. 64p. Dep. CFSTI.

Research during 1968 on washout and rainout of radioactive debris in Illinois is summarized in four papers on the tracing of tropospheric radioactive debris by isentopic trajectories, an investigation of atmospheric motions on a subsynoptic scale, and laboratory and field research on the washout and rainout of submicron particulates. The method of using indium as a tracer for studying convective cloud motions and for determining from particle size how the tracer material is removed from a precipitating cloud is described, but results of the method are not available. The results of a statistical analysis to determine the relationship between gross beta radioactivity in air and the activity in concurrent precipitation is presented. An appendix with data on tritium concentration in the atmosphere over Illinois is included. (L.C.L.)

7638 (DP-1163) THE SRL METEOROLOGICAL PROGRAM AND OFF-SITE DOSE CALCULATIONS. Cooper, R. E.; Rusche, B. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1968. Contract AT(07-2)-1. 150p. Dep. CFSTI.

Micrometeorological data from instruments mounted on a 1200-foot TV tower were recorded once each three minutes for a period of two years. The data were converted to ordinary dispersion parameters using correlation equations. The derived dispersion parameters and relevant micrometeorological data were used to derive dose-frequency distribution for an assumed accidental release of radionuclides from a reactor operating at 1000 MW. The dose-frequency distributions are presented for assumed release heights of 230 and 850 feet (70 and 260 meters). (auth)

7639 (NP-17698) MEASUREMENT OF RADIOACTIVE FALLOUT IN MOL. Annual [Report], 1966. Boulenger, R.; de Maere, X. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 127p. (In French). (R-2429). Dep.

The radioactive fallout measured at Mol in 1966 in dust suspended in the air and at ground level, in precipitations, and in milk is reported in graphic and tabular form. (J.S.R.)

7640 (TID-24635) SOURCES OF TRITIUM AND ITS BEHAVIOR UPON RELEASE TO THE ENVIRONMENT. AEC Critical Review Series. Jacobs, D. G. (Oak Ridge National Lab., Tenn.). 1968. Contract W-7405-eng-26. 90p. Dep. CFSTI.

An attempt is made to summarize some of the important properties of tritium and to use these properties in predicting the impact of diverse releases of tritium on local and worldwide populations. Sources of tritium production and its release, procedures for tritium enrichment, monitoring practices and instruments for the detection and assay of tritium, tritium movement in the environment, and projected tritium production in a nuclear power economy are discussed topically. Areas in which more precise knowledge is needed to improve estimates of environmental contamination are indicated. (C.E.S.)

7641 USING ATMOSPHERIC RADIOACTIVITY FOR INVESTIGATION OF AIR MASS MOVEMENTS. Vilenskii, V. D.; Kuzenkov, A. F. At. Energ. (USSR), 25: 242-3(Sept. 1968). (In Russian).

An attempt was made to determine simultaneously the content of ^{90}Sr and ^{210}Pb at various elevations of upper troposphere and to evaluate the large scale vertical air motion effects of the migration of these isotopes in the atmosphere. Aerosol specimens were taken at the elevation of 9 to 12 km around Moscow and Tbilisi regions in 1963. A maximum concentration of ^{210}Pb and a reduced content of ^{90}Sr were recorded during the period between July 28 and 31. The ratio concentration of $^{90}Sr/^{210}Pb$ was very low. Statistical data obtained confirmed a certain bond between the radioactive fallout and vertical motion in upper troposphere. It is found that the simultaneous measurements of natural and artificial radioactive products can be used for studies of large scale vertical motions in atmosphere. (R.V.J.)

7642 CHARGING OF α-ACTIVE AEROSOLS AS A RESULT OF SECONDARY ELECTRON EMISSION. Ivanov, V. D.; Kirichenko, V. N.; Petryanov, I. V. Dokl. Akad. Nauk SSSR, 182: 307-9(Sept. 11, 1968). (In Russian).

Radioactive aerosols may acquire a charge either by capturing gas ions or by the emission of electrons. Contribution of secondary emission is quite high in the case of "hot" aerosols. The problem was experimentally studied by determining the charge changes of aerosol particles as a result of secondary electron emission which accompanies the α-decay and examining the unipolar charging of particles. The dimensions and charge of aerosols were determined by photographing them and analyzing their trajectory in a horizontal electric field. The monodisperse dibutyl phthalate aerosols containing 10^3 to 10^4 particles/cm^3 were mixed with radon-222 and activated with the latter's decay products. It was found that the actual mean positive charge acquired by an aerosol particle during the α-decay is close to 12 electron charges. Study of the possible unipolar charge indicated that the distribution curve has a steep rate of increase in the positive region, with a maximum at 9 and decreasing slowly toward 40 elementary charges. (TTT)

7643 AN ORIGINAL METHOD FOR THE MEASUREMENT OF THE ATMOSPHERIC DIFFUSION USING A RADIOACTIVE GAS EMITTED FROM A POINT SOURCE. Druilhet, Aime; Fontan, Jacques; Biasini, Hubert; Blanc, Daniel (Faculte des Sciences, Toulouse). Compt. Rend., Ser. A and B, 267: 741-4 (Oct. 7, 1968). (In French).

The method is based on the determination of a radioactive gas, radon-220, emitted into the atmosphere continuously from a point source; it makes it possible to study the diffusion of matter in the boundary layer of the atmosphere. Radon produces no pollution of the air because of its short half-life and low radioactivity. (tr-auth)

7644 EDDY VELOCITIES IN THE PLANETARY BOUNDARY LAYER AS OBTAINED FROM TETROON FLIGHTS AT IDAHO FALLS. Dickson, C. R. (Environmental Science Services Administration, Idaho Falls, Idaho); Angell, J. K. J. Appl. Meteorol., 7: 986-93(Dec. 1968).

Tetroon flights made at the National Reactor Testing Station, Idaho Falls, during the past few years have provided values of eddy velocity within the planetary boundary layer. In this desert-like terrain the root mean square (rms) values of longitudinal, lateral and vertical velocity tend to increase with height based on daytime observations throughout the year. The respective turbulence intensities, however, decrease with height. The mean values of rms velocity increase by factors of 2 to 3 between winter and summer. On the basis of an extensive tetroon experiment in summer, when lapse-rate data are available, the rms vertical velocity increases markedly with increase in height, lapse rate and wind speed during the day, whereas the rms lateral velocity is proportional chiefly to wind speed. The average vertical turbulence intensity is more than twice as large as the year-average value obtained by Pasquill in England, but decreases with height in a similar manner. The variation with height, stability and wind speed of both the vertical momentum flux and the rate of production of eddy kinetic energy from the mean sheared flow are indicated. (auth)

7645 ^{90}Sr IN THE AUSTRALIAN ENVIRONMENT DURING 1967. Fletcher, W. (United Kingdom Atomic Energy Authority, Capenhurst, Eng.); Gibbs, W. J.; Moroney, J. R. Aust. J. Sci., 31: 174-9(Nov. 1968).

The mean annual deposition of ^{90}Sr in precipitation at eight

monitoring sites in Australia is given for the period 1958 to 1967. The mean deposition during 1967 was the lowest for any year since monitoring began in 1958. Of the eight stations, Sydney showed the highest annual deposition, namely 0.8 mCi/km^2, and Darwin the lowest at 0.4 mCi/km^2. (auth)

7646 CONCENTRATIONS OF ^{137}Cs IN RAINWATER AND MILK IN AUSTRALIA DURING 1967. Bonnyman, J.; Duggleby, J. C.; Molina-Ramos, J.; Paterson, I. C. (Commonwealth X-Ray and Radium Lab., Melbourne). Aust. J. Sci., 31: 180-3(Nov. 1968).

The annual cesium-137 deposition in Australia in 1967 was lower at all stations than the corresponding deposition for each of the previous three years for which comprehensive data are available. The average annual concentration of cesium-137 in milk for all Australian sampling centers was, in 1967, the lowest for the five years 1963 to 1967 in which the comprehensive monitoring program has been in operation. The average concentration for all centers in 1967 showed a 30% decrease over the previous year. The relative concentration of cesium-137 in milk processed for consumption in Perth was higher than in milk from other sampling centers with similar cesium-137 deposition patterns. This could be due to widespread supplementary feeding, type of pasture, type of soil and pattern of rainfall. The French nuclear weapon tests in Polynesia in 1966 and 1967 have had no noticeable effect on the overall downward trends of cesium-137 deposition and concentrations in milk. In the absence of large-scale nuclear weapon testing, the amounts of cesium-137 in deposition and milk in Australia should continue to decrease as the level of cesium-137 in the stratospheric reservoir falls. (auth)

7647 ATMOSPHERIC REFRACTION AND FOCUS OF BLAST WAVES. Viecelli, James (Univ. of California, Livermore). J. Geophys. Res., 72: 2469-83(May 15, 1967).

An integral solution to the wave equation in an inhomogeneous half-space is used to derive the time-dependent pressure variation in the neighborhood of a first focus. Theoretically calculated signals are compared with barograph records. It was concluded that the curve of maximum peak-to-peak pressure versus distance is bell shaped and the dome of the bell is located on the far side of the caustic; width of the bell is proportional to the 2/9 power of the energy released to the atmosphere; height of the dome is proportional to the 5/18 power of the energy release; the signal wave shape is quite sensitive to position near the caustic; on the side the signal consists of a single long smooth wave; at the caustic the wave steepens into a spike followed by a dip; on the far side the signal divides into two separate portions, a relatively smooth wave followed by a period of silence followed by a wave containing a spike; close correlation between theoretical and observed signals is unlikely for a single event at a single recording station; and the theoretical focus is narrower and more intense than that experimentally observed. (auth)

7648 SOURCES OF RADIOACTIVE POLLUTION. VOLUME I. Eisenbud, Merril. pp 121-47 of Air Pollution. Vol. I. Stern, Arthur C. (ed.). New York, Academic Press, 1968.

In addition to its public health implications, the artificially produced component of atmospheric radioactivity has attracted the attention of geophysicists who find both the natural and artificial radionuclides in the atmosphere to be useful as tracers in the study of various atmospheric transport mechanisms. Natural radioactivity of terrestrial and cosmic ray origin is discussed including the average content of radioactive elements and their active isotopes in igneous rocks, approximate decay schemes of ^{226}Ra and ^{228}Ra, measurements of natural radioactivity in ground-level air; and productive rates, tropospheric concentration, and detection of cosmic ray-produced radionuclides; and the buildup and decay of radioactivity. The importance of ^{14}C is discussed; the concentration of ^{14}C increased gradually to about 90% above normal between 1954 and 1963. Properties of fission and activation products are discussed including a tabulation of the more important radionuclides produced by nuclear reactions and their half-lives. A block diagram of processes in the atomic energy industry is presented. The pollution hazards of various types of nuclear reactors are treated. Cumulative deposition of ^{90}Sr as of the end of 1962 shows that the deposition in northern latitudes is >4 times that below the equator. The relatively new potential source of atmospheric radioactivity, the use of nuclear energy for rocket propulsion, and as a source of power for the operation of satellites and space probes, is discussed. (Meteorol. Geoastrophys. Abstr.)

Mineralogy and Exploration

7649 NUCLEAR INDUSTRY 68. PART I. NUCLEAR POWER SUPPLY INDUSTRY. Nucl. News, 12: 21-37(Jan. 1969).

The cost, demand, and supply of fuels for the nuclear power supply industry in the U. S. through 1980 are examined at all levels from mining of uranium ores through spent fuel reprocessing and recovery of fissionable materials. The private companies involved in each phase are named, and the degree of present envolvement and future potential outlined. The exploration industry is considered bullish with an 8-fold increase in demand for uranium ores to meet 1980 needs in the U. S. predicted. The volume of enrichment and fuel fabrication business is estimated to grow at a lesser rate ranging from 3:1 to 6:1. Enrichment by private industry is considered probable. (L.C.L.)

7650 SEISMIC PROSPECTING IN THE ENVIRONS OF URANIUM ORE DEPOSITS AT THE NORTHERN PART OF TOKI CITY, GIFU PREFECTURE. GEOPHYSICAL PROSPECTING IN THE TONO AREA. PART II. Hirasawa, Kiyoshi; Ito, Kosuke. Chishitsu Chosasho Geppo, 18: No. 9, 1-14(1967). (In Japanese).

Seismic prospecting in the same area in 1964 was reported by Hirasawa. A refraction survey was carried out in 1965 on five traverse lines, and as a result a subsurface contour map (interval: 10 m) of the granitic basement was obtained. The basement consists of two valleys separated by a saddle. The eastern valley trends NNE, and the western valley has two branches trending NE. The saddle structure forms a buried peninsula and a reef, as expected from results of seismic prospecting in 1964. Good correlation was found with results of electrical prospecting. (Geophys. Abstr.)

7651 URANIUM FROM SWEDISH SLATE. Haehnel, S. Tek. Tidskr., 98: 825-8(1968). (In Swedish).

A review is presented of the analysis of Swedish slate for U made by Aktiebolaget Atomenergi on behalf of the Swedish Ministry of Finance. (Sweden)

Oceanography

Refer to abstract 7640.

Seismology

Refer also to abstract 7655.

7652 (FOA-4-4375) CHARGE MASS AND ELEVATION INFLUENCE ON SEISMIC WAVES FROM SMALL CHEMICAL EXPLOSIONS ABOVE GROUND. Dahlman, O.; Axelsson, H.; Edin, K. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1968. 29p. Dep.

Seismic Rayleigh and Pg waves from aerial chemical explosions, with yields from 0.05 to 5 kg, detonated at elevations between 0.1 and 10 m were studied at 300, 600, and 1200 m distance. Consecutive explosions under the same conditions over the same epicenter show significant Rayleigh wave amplitude changes between the first five or ten explosions. The Pg wave amplitudes were found to be proportional to the 0.57 power of yield. For the Rayleigh wave the amplitudes were found proportional to the 0.69 power of yield for yields above 0.25 kg and proportional to the yield for lower yields. For each yield, wave-phase and recording-distance there exists an optimal elevation, so that a charge fired at that elevation gives larger wave amplitudes than if fired at higher or lower elevation. The Pg wave amplitudes were found to decrease almost inversely proportional to the distance. The Rayleigh waves are attenuated not only through geometrical spreading but also through very high absorption over the first 300 to 600 m. (auth)

7653 (UCRL-50500) GERED: A CODE FOR EQUATION-OF-STATE CALCULATIONS AT MODERATE PRESSURES. Rogers, F. J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 9, 1968. 49p. DTIE.

A FORTRAN code which is used to convert shock wave data into equation-of-state information through the Dugdale-MacDonald, Slater, or free-volume gamma relationship and the Mie-Grüneisen equation of state is described. The code is written to allow flexibility in the calculation of the particle velocity associated with a given free-surface velocity measured in a shock experiment. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstract 7647.

7654 (PNE-200-F) FINAL OFF-SITE REPORT OF THE PROJECT SEDAN EVENT, JULY 6, 1962. PLOWSHARE PROGRAM. Placak, O. R. (Public Health Service, Las Vegas, Nev.). Dec. 12, 1962. 85p. Dep. CFSTI.

The Project Sedan event was conducted as a part of the Plowshare Program at 1000 hours on July 6, 1962, in Area 10 of the Nevada Test Site by the Lawrence Radiation Laboratory. The Project Sedan nuclear cratering experiment resulted in the formation of a radioactive cloud which drifted northward on a 10 degree bearing for 40 miles to the vicinity of Queen City Summit, and then moved on a 20 degree bearing to Ely. From here, a nighttime wind shift carried the cloud eastward. The highest estimated total infinite exposure dose received at a populated location from the Project Sedan event was 945 mR at Diablo (population eight), and the second highest was 226 mR at Penoyer (population two). These are calculated infinite doses. Personal film badges worn by the residents and collected on July 9, 1962, indicate 150 to 170 mR dose at these two locations. In order to ensure a minimum of exposure, the people at these two locations and Tempiute (population three), were relocated during cloud passage. The results of monitoring and environmental sampling efforts conducted by the U. S. Public Health Service Off-Site Radiological Safety Organization are presented. (auth)

7655 (PNE-906) PRESHOT GEOPHYSICAL PROPERTIES OF PALANQUIN CRATER SITE. Project PALANQUIN. Stearns, Ronald T.; Meyer, G. Lewis (California Univ., Mercury, Nev. Lawrence Radiation Lab.); Hansen, Spenst M. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 1968. 26p. (UCRL-50411). Dep. CFSTI.

The Palanquin nuclear cratering experiment was conducted on April 14, 1965 at the Nevada Test Site of the U. S. Atomic Energy Commission. Eight preshot holes were drilled consisting of the emplacement hole, two instrument holes, and five exploratory holes. The maximum depth reached was 187 m. Rocks at the site are of volcanic origin, and consist predominantly of trachyte porphyry of the Ribbon Cliff formation of Pliocene age. Pyroclastic volcanic tuff underlies the trachyte porphyry at a depth of 175 m and caps low hills adjacent to the site. The volcanic units have a general horizontal attitude, although flow structures show gentle-to-steep dips. No ground water was encountered. The physical properties of the trachyte porphyry medium show considerable variation. Zones of jointing and brecciation are widespread, particularly in the upper 60 m, with caliche and clay surrounding blocks and fragments of rock. These zones caused severe out-of-gauge conditions in the drill holes, and poor recovery. No evidence of faulting in the vicinity of surface ground zero was found. Logs used in the drill holes of the Palanquin site were the gamma-gamma density, caliper, seismic velocity, drilling and coring time, and percent core recovery. These logs were made with instruments furnished by and operated by the Welex Division. Logs were also constructed from drilling and coring penetration rates, and from % core recovery. In situ sonic velocity measurements were made in several of the drill holes. All logs were run in open, dry holes, since the highly fractured rock medium precluded filling the holes with fluid. In situ velocity measurements were made using the seismic uphole logging technique developed at the Lawrence Radiation Laboratory. Average velocities of 907 and 2,427 m/sec were measured. A velocity discontinuity was located at a depth of approximately 27 m. Measurements of in situ physical properties at nuclear experiment sites prior to the investigations at Palanquin were sparse. The geophysical measurements at the Palanquin site assisted in the development of improved techniques, and demonstrated the need for high-resolution logging tools and methods. (auth)

7656 (TEI-873) POTENTIAL APPLICATIONS OF NUCLEAR EXPLOSIVES IN DEVELOPMENT AND MANAGEMENT OF WATER RESOURCES. PRELIMINARY CANVASS OF THE GROUND-WATER ENVIRONMENT. Piper, Arthur M. (Geological Survey, Washington, D. C.). 1968. 173p. Dep. CFSTI.

A preliminary survey of the ground water environment within the U.S. to identify areas and sites that conceivably offer hydrologic advantages in the use of nuclear explosives in the development and management of water resources is discussed. The potentials for nuclear detonation are presented by ground water provinces. These include the Pacific Border mountains, Alluvial Valleys and Basins, Columbia Plateau, Rocky Mountains, Colorado Plateaus and Wyoming Basin, High Plains, unglaciated Central Lowland and plains, glaciated Central Lowland and plains, unglaciated Appalachia, and the Atlantic and Gulf Coastal Plain. Restrictions on practicable nuclear detonations are summarized. These restrictions derive from uncertainty as to dimensions of cavity and collapse chimney formed by a detonation at depth, side effects of detonation, e.g., ground motion, air blast, and dispersal of radioisotopes produced by the detonation, comparative economics of nuclear versus conventional methods, and legal considerations. (R.C.K.)

Facilities and Equipment

Refer also to abstracts 7718, 8280, 8559, 9138, and 9221.

7657 (BMwF-FBK-68-28) CALCULATION OF THE CRITICAL SPEEDS OF MULTISECTION ROTORS OF HIGH-SPEED ROTATING MACHINERY. Weidner, P.; Zippe, G. (Gesellschaft fuer Kernverfahrenstechnik m.b.H., Juelich (West Germany)). July 1968. 26p. (In German). Dep.

The critical speeds of elastically coupled chains of gyroscopes are mathematically treated. The equations of motion are formulated as Lagrange's equations; the critical frequencies result from the characteristic determinant of the system. Longitudinal vibrations and elastic coupling of the ends are taken into account. Friction and gravity forces are neglected. The transition to the homogeneous shaft is included. (auth)

7658 (CEA-R-3592) APPLICATIONS OF SUB-OPTIMALITY IN DYNAMIC PROGRAMMING TO LOCATION AND CONSTRUCTION OF NUCLEAR FUEL PROCESSING PLANT. Thiriet, Lucien; Deledicq, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 41p. (In French). Dep.

A brief summary of the application of dynamic programming to optimization and operational research problems in the chemical industry is presented. Conditions of dynamic programming are illustrated by a sequential graph. A new algorithm for the determination of sub-optimal policies was developed. Examples of the application of the algorithm for siting fuel reprocessing plants, assuming knowledge of the location and long-term annual production of the reactors, possible location of the reprocessing plant and the cost of uranium transport, are given. (F.S.)

7659 (IITRI-578-P-21-10) SWIMM CODE: STRESS WAVE PROPAGATION IN ELASTIC-PLASTIC-COMPACTIBLE MEDIA. Volume IV (of Five Volumes on Blast Shields). Final Report on Task I. Eichler, John B. (IIT Research Inst., Chicago, Ill.). Aug. 1968. Contract AT(11-1)-578. 192p. Dep. CFSTI.

The SWIMM code was written in FORTRAN II for use on an IBM 7094 high speed digital computer. Its purpose is to calculate one-dimensional uniaxial stress wave attenuation in layered materials containing from one to forty layers. The general manner in which the code was written provides a valuable tool for the analysis of such stress wave problems. A summary of the application of the equations used, a discussion of the objective of each SWIMM code subroutine, and the instructions for using the SWIMM code are included. Also included is a listing of the SWIMM code. One solved problem is presented. (auth)

7660 (JAERI-1167) RECOVERY OF KRYPTON BY ADSORPTION PROCESS. Kitani, Susumu; Uno, Seiichiro; Takada, Junichi; Takada, Hiroshi; Segawa, Takeshi (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). June 1968. 10p. Dep.

The work carried out to obtain data necessary for design of a plant for krypton recovery by the adsorption of Kr from the off-gases in spent fuel reprocessing is discussed. The breakthrough of Kr from an adsorption column was measured with ^{85}Kr as the tracer. The adsorption capacity of krypton on various adsorbents, e.g., activated charcoal and Molecular Sieves AW-500, was studied dynamically. The mass transfer coefficient of dynamic adsorption was calculated by Kawazoe's method. The effects of temperature pressure, particle size of the adsorbent and carrier gas on krypton adsorption were investigated for an activated charcoal (Tsurumi-GLS). The results obtained will be useful in the design of a plant for recovery of krypton and xenon by adsorption process. (auth)

7661 (JAERI-4046) SURVEY OF THE LITERATURE ON THE CHARACTERISTICS OF AIR SAMPLING FILTER PAPER. Yoshida, Yoshikazu; Ikezawa, Yoshio (Japan Atomic Energy Re-

search Inst., Tokai. Tokai Research Establishment). June 1968. 25p. Dep.

The important characteristics of air sampling filters are collection efficiency, flow resistance, and surface collection efficiency. These characteristics depend not only on the kind of filter medium but also on the properties of an aerosol for sampling, and also on the sampling conditions. A survey was made on the literature for air sampling filters used in operational health physics, and the important data are given. (auth)

7662 (LA-3991) ONE-STEP CLOSURE SEALING OF PRESSURIZED CAPILLARY TUBING. Giles, Paul M.; Esch, Karl A. (Los Alamos Scientific Lab., N. Mex.). Sept. 1968. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Since 1964 the Los Alamos Scientific Laboratory of the University of California has routinely sealed Type 304-L stainless steel capillary tubes, pressurized to as high as 24 kpsi, by pinch welding. Welds of tubing under pressure, made upon intermittent demand over this 4-year period, have without exception exhibited leak rates of less than 10^{-10} standard cc/sec. A summary of the method, equipment, welding parameters, and some auxiliary techniques is presented. (auth)

7663 (NP-tr-1711) IMPROVEMENTS IN THE IRRADIATION OF MATERIALS. Norman, John Roy. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Belgian Patent 699,967. 13p. Dep.

A method of continuous treatment of a material by electron irradiation of materials is described. The method includes subjecting the material to at least five successive doses of low-energy electron irradiation of substantially equal intensity and energy. (auth)

7664 (ORNL-4370, pp 212-18) REACTOR EVALUATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The potential of various reactor systems was analyzed by evaluating fuel fabrication costs and fuel element performance. Emphasis was placed upon updating Civilian Nuclear Power, A Report to the President—1962 and evaluating reactors for desalination. The code for estimating fuel fabrication costs for pin-type fuel elements was updated and computer codes were developed for optimizing plant expansions and determining when recycle of fuel should be undertaken in a growing nuclear power economy. Development of a model and computer code for performance of pin-type fuel elements was started. (auth)

7665 (ORNL-TM-2346) PLANT SIZE OPTIMIZATION IN A GROWING NUCLEAR FUEL FABRICATION INDUSTRY. Homan, F. J. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 81p. Dep. CFSTI.

Fuel fabrication costs are a substantial fraction of the total cost of nuclear power. The size of fabrication plants with respect to the total market heavily influences the cost of fabrication. Fuel can be fabricated much more cheaply in a large facility than in a small one, assuming both facilities are fully loaded. On the other hand, it is inefficient and expensive to operate a large, partially loaded facility. A method of achieving a balance between these effects so as to produce a minimum in a cost versus plant size curve is described. A basis for assignment of an initial fabrication price is also suggested. (auth)

7666 (SC-TM-68-419) "ACCEL" GRAPHICS SYSTEM. Caskey, D. L. (Sandia Labs., Albuquerque, N. Mex.). July 1968. 26p. Dep. CFSTI.

Some graphic intervention capability has been added to the ACCEL system. ACCEL is a computer program to lay out printed circuit boards and produce drawings for their construction. The input to ACCEL is encoded from an engineer's schematic by a clerk. ACCEL is written in FORTRAN II for the IBM 7090/7094 computer and the drawings are produced on the Stromberg Carlson SC-4020 cathode-ray tube plotter. The graphic additions allow the ACCEL-generated placement of components to be displayed on a PDP-7 graphic system, and necessary and/or desired changes to be made via light pen. ACCEL then continues as before to produce the routing and drawings. See SC-TM-65-544 for a discussion of ACCEL. (auth)

7667 (TID-4100(Suppl.48)) ENGINEERING MATERIALS LIST. Supplement 48. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Dec. 1968. 45p. DTIE Free.

Twenty-three packages of engineering materials are described. Drawings of the following equipment are included: cable calibrator, RF separator, equipment for sol-gel microsphere forming and drying, equipment for measuring total and differential cross sections for ion-neutral interactions, preamplifier, intervalometer, wiped film evaporator, air gage pot chuck, radiation detectors, cosmic ray telescope, thermocouple protector, amplifier, waveguide network, magnet measurement rotating coil drive, vacuum flange and gasket, carbohydrate analyzer, velocity readout, isotope heat source tester, tomographic gamma ray scanner, double wall heat exchanger, and differential or integral discriminator. (R.C.K.)

7668 (TRG-Report-1208) BOLTED FLANGED JOINTS FOR HIGH-TEMPERATURE SERVICE. White, W. P., Bromidge, N. A. C. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. 72p. Dep. CFSTI. UK.

A program to develop demountable bolted flanged joints to meet exacting requirements for leak-tightness at high temperatures and at high pressures is described. Several proprietary joints were tested but none was satisfactory, so a new type was developed, using a thin soft metal gasket which is compressed plastically between controlled finish surfaces on the mating hubs. The new design, which was patented, can be used in practically any environment when the right choice of materials is made, and it remains substantially leak-tight at all temperatures up to 600°C, and in some cases higher temperatures. The joint will withstand pressures significantly greater than the safe working pressures of the adjoining pipes, and its performance is not impaired by alternating applied bending moments or torsion. Results of exhaustive tests made on several sizes of joints are given. The leak-rates of the joints tested were of the order of 10^{-9} atm/cm^3 sec per cm peripheral length of gasket, and were not measurably affected by changes of pressure. Complete detail designs are included for joints up to 6 in. in diameter, and sufficient design data are given for successful joints to be made in much larger sizes. Future requirements are anticipated for joints working at temperatures up to 1000°C and some suggestions are made for further development. (auth)

7669 SEALING RING ASSEMBLIES. Hamilton, John; Walton, Frank (to United Kingdom Atomic Energy Authority). British Patent 1,134,096. Nov. 20, 1968. Filed Nov. 17, 1965.

The described ring assembly for sealing at ungrooved flanges has inner and outer annular rigid guide rings and a sealing member between the guide rings arranged so that the walls of the guide rings and sealing member are relatively recessed to accept deformation of the latter. The sealing member is slightly greater in thickness than the guide rings in the undeformed state and is of PTFE or has PTFE-like properties in respect of chemical inertness and its being incompressible in bulk, yet deformable; it has flat sealing faces for sealing on the ungrooved flange faces before and after deformation. (UK)

7670 IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF CUTTING EDGES. Symons, Norman Kendall Jelinger (to Wilkinson Sword Ltd.). British Patent 1,133,982. Nov. 20, 1968. Filed Nov. 10, 1964.

A method is described of providing a polymer coating on a cutting edge by depositing a polymerisable substance and then inducing polymerisation by irradiation. The polymer coating is shown to improve the cutting effectiveness of the edge. The use of irradiation to effect polymerisation avoids exposing the cutting edge to high temperatures. (UK)

7671 STEAM TURBINES WITH HOLLOW POROUS STATOR BLADES. Linning, David Lees (to United Kingdom Atomic Energy Authority). British Patent 1,135,176. Dec. 4, 1968. Filed Apr. 26, 1966.

A steam turbine is described which is provided with hollow porous stator blades arranged so that the hollow centres in the blades open to an annular collector and the collector opens directly at substantially full area over the downstream face of the collector annulus into a lower pressure region, such as the exhaust manifold, of the turbine. This arrangement allows relatively large volume flows with only small pressure drops and it becomes possible not only to remove moisture accumulating on the stator blades but also to affect the steam boundary layer so as to reduce flow breakaway from the convex side of the blades. A modified form allows water to be applied to the inner surfaces of the blades to prevent water drawn through the blades flashing into steam, and to reduce surface tension effects. (UK)

7672 IMPROVEMENTS IN OR RELATING TO MECHANICAL TESTING EQUIPMENT. Sumner, Gerald (to United Kingdom Atomic Energy Authority). British Patent 1,135,227. Dec. 4, 1968. Filed Dec. 14, 1965.

A specimen grip for a fatigue testing machine is described. The grip has a taper bore to fit the corresponding tapered end of a test specimen, a draw bar in axial alignment with the taper bore adapted to couple with the tapered end of a test specimen, and means for driving the draw bar so that the tapered end of the test specimen may be drawn into tight engagement with

the taper bore in the grip. A degree of pressure may be applied such that engagement of the tapered end of the test specimen in the taper bore in the grip is positively maintained throughout cyclic straining of the test specimen between axial compressive and tensile loading. The draw bar is screw-threaded to couple with the tapered end of the test specimen and is driven by a worm wheel mounted on the draw bar and actuated by a worm shaft mounted in the grip. A heater is provided in the grip, surrounding the test specimen, so that the specimen may be heated by conduction. Cooling means are provided for the worm mechanism. (UK)

7673 SYSTEM FOR MEASURING RADIOACTIVE ISOTOPES IN DILUTE SOLUTION. Riel, Gordon K. (to Secretary of the Navy). U. S. Patent 3,409,771. Nov. 5, 1968. Filed Nov. 3, 1966.

An apparatus is described for measuring radioactive isotopes in very dilute solutions. The solution is pumped through a porous filter supporting a loosely packed, radioactive isotope extracting resin. A detector positioned adjacent the filter measures the radioactive isotopes trapped by the resin. (Offic. Gaz.)

7674 INDUCTION FURNACE. Briand, Alain (to Commissariat a l'Energie Atomique). British Patent 1,134,442. Nov. 20, 1968. Priority date Jan. 20, 1965, France.

An electromagnetic induction furnace which can be used as an irradiation furnace for heating a test specimen being irradiated in a reactor, crimping specimens in a metallic mass, or in any case in which it is important to rapidly cool a specimen which has been heated to a high temperature is described. The furnace consists of a mass of electrically conductive material pierced by two bores, one of which holds the test specimen and the other contains an induction coil connected to an ac voltage source. Passages for cooling fluid circulation are provided for cooling the equipment. (F.S.)

7675 IMPROVEMENTS IN OR RELATING TO ARRANGEMENTS FOR GUIDING AND SUPPORTING APPARATUS ROTATABLE ABOUT A VERTICAL AXIS. Gobert, Gerald (to Commissariat a l'Energie Atomique). British Patent 1,134,038. Nov. 20, 1968. Priority date July 28, 1965, France.

An arrangement is described for guiding and supporting an apparatus that is rotatable about a vertical axis at rotational speeds of 80,000 to 120,000 rpm. The arrangement consists of two radial bearings for guiding, and an axial bearing with a spherical-shaped surface for supporting the apparatus. The axial bearing is located at a position between the radial bearings and as close as possible to the center of gravity of the apparatus. Gas under pressure is supplied to the bearings during operation. (F.S.)

7676 HERMETIC MOUNTING FOR AN α-PROBE IN A GLOVEBOX. Godart, Michel; Huon, Jean-Pierre; Pajot, Jaques Rene (to Commissariat a l'Energie Atomique). British Patent 1,136,369. Dec. 11, 1968. Priority date Nov. 15, 1966, France.

An apparatus for hermetically placing an α probe in a glovebox is described. The α probe is used to measure contamination in a box containing a He atmosphere. The probe is connected by a coaxial cable to an integrator outside the glovebox. The apparatus consists of an opaque hermetic probe member mounted in the glovebox on a movable support and a body containing an α probe scavenged by a fluid which enters and is discharged from the box through hermetic passages. (F.S.)

7677 METHOD OF JOINING TWO TUBULAR ELEMENTS FORMED OF NON-WELDABLE METALS AND JOINT OBTAINED. Foulquier, Henri; Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,137,310. Dec. 18, 1968. Priority date Oct. 14, 1966, France.

A method is described for joining two tubular elements formed of non-weldable metals. The tubes are provided respectively with a male tube-end and a female tube-end. A brazing strip is interposed between the two tube elements which are then fitted together, and an annular retaining collar to prevent expansion is placed around the female tube-end. The assembly is heated to the melting temperature of the brazing alloy, and subsequently cooled. The joint obtained is claimed to have excellent leak tightness and improved mechanical strength. (L.C.L.)

7678 NEUTRON COLLIMATOR. Yamaki, Hideo (to Hitachi Ltd.). Japanese Patent 1968-18515. Aug. 8, 1968. Filed Sept. 24, 1962.

A neutron collimator is described that provides precise collimation, is simple to construct, is small in size with no movable parts, and gives complete shielding of neutrons. It consists of two partitioning plates placed at appropriate positions in the passage of neutrons; a number of chambers produced in the two spaces by means of concentric annular walls; and, a means for filling or drawing out a neutron-absorbing liquid to and from the chambers. (NSA of Japan)

7679 HOT SAMPLE CHANGER AND TRANSFER CASK FOR THE NUCLEAR EXPLOSION NEUTRON SOURCE EXPERIMENT. Miller, L. G. (Idaho Nuclear Corp., Idaho Falls); Miller, H. G.; Ellis, A. N. Nucl. Instrum. Methods, 67: 121-4(Jan. 1, 1969).

With the availability of a high-intensity neutron beam from an underground nuclear explosion, it is possible to measure short half-life isotopes a few hours after final separation and before the build-up of decay products. The decay-product contaminants may be considered constant during the measurement as the measuring time is only a few msec. A hot-sample changer was built in conjunction with Los Alamos Scientific Laboratory to measure neutron cross sections using time-of-flight methods on samples of high activity and short half-lives (a few days). Samples are produced by neutron irradiation in the Materials Testing Reactor (MTR) and prepared in hot cells. They are flown to the Nevada Test Site (NTS) for insertion into the sample-changer cask a few hours before the experiment. The sample is moved into beam position 15 sec before the device is detonated and is returned to the changer cask immediately thereafter. The capture cross section of the nuclide ^{147}Pm was measured in the spring of 1967 and served as a dry run for the sample ^{233}Pa, which is being measured in a current experiment. (auth)

7680 LINEAR INDUCTION LIQUID METAL PUMP (Engineering Materials). (Argonne National Lab., Ill.). (CAPE–1790). 23 drawings.

An annular linear induction pump (ALIP), of the electromagnetic type, suitable for use in a high-pressure, high-temperature radioactive environment is described. The pump is capable of operating at 500°C and will deliver 25 gal Na per min at 20 psi with an efficiency of 7%. The pump tube, capable of withstanding a static pressure of 340 atm (5000 psi), is fabricated of age-hardened Inconel X-750. (For details see TID-4100) (see also 22: 44884). (F.S.)

7681 APPARATUS FOR IRRADIATING GOODS DURING MOVEMENT PAST A RADIOACTIVE SOURCE MOUNTED IN A SHIELD ENCLOSURE. Armel, Jack (to Parsons-Jurden Corp.). U. S. Patent 3,411,002. Nov. 12, 1968. Filed June 19, 1963.

An irradiator is described which consists of a substantially closed shell of radiation-absorbing material providing an enclosed volume, a radiation source means in the form of a slab centrally disposed in the enclosed volume and spaced from opposite sides thereof to provide passageways extending longitudinally along opposite sides of the slab, the slab also being spaced from at least one end of the enclosed volume to provide a passageway extending transversely across the end of the enclosed volume; and a transfer means including a loading breech made of radiation absorbing material slidable in a recess in the substantially closed shell. A method is provided for transferring successive units of material to be irradiated into the enclosed volume in sequence and for transferring irradiated units out of the enclosed volume in sequence, and for conveying the units to be irradiated by intermittent motion with intervening dwell periods of selected duration along successive paths within the enclosure extending along one side, across one end, and along the other side of the radiation source means. (Offic. Gaz.)

7682 PROCESS AND DEVICE FOR THE DISCHARGE OF FISSION GASES FROM NUCLEAR FUEL ELEMENTS. Beisswenger, Heinrich; de Temple, Bernhard. U. S. Patent 3,406,094. Oct. 15, 1968. Priority date June 3, 1964, Germany.

A device for removing fission gases from nuclear reactor fuel elements is described. It consists of a fuel element in which fission gases develop; a fission-gas discharge device attached to the fuel element; a chamber including an inlet and an outlet through which the gases are adapted to flow in a path extending from the inlet to the outlet; and means for throttling the flow of such gases through the chamber. (Offic. Gaz.)

7683 APPARATUS FOR TESTING THE RADIOACTIVITY OF AIR. Garnier, Andre (to Societe Siersatom). U. S. Patent 3,410,059. Nov. 12, 1968. Priority date Apr. 8, 1966, France.

An apparatus for sampling aerosols, especially for sampling air contaminated by radioactive particles is described. It consists of a closed case connected to a filter by means of a flexible hose, an electric motor and a separate supply battery, and a piston coupled to the motor by a transmission unit. The piston is driven in reciprocating translational motion within a cylinder which is rigidly fixed to the case. Two flexible membranes form the two cavities in the cylinder having a volume which is variable in inverse ratio. Valves for the admission and discharge of contaminated air into and from each of the cavities and an opening for discharging air from the case are provided. (Offic. Gaz.)

7684 A RADIATION SHIELDED SOURCE CONTAINER WITH AN ELECTROMECHANICALLY OPERATED PLUG FOR TWO

RADIOACTIVE SOURCES. Hartlep, M. PTB Mitt., 78: 376-9(Oct. 1968). (In German).

A radiation shield and container for radioactive sources suitable for dosimetric uses is described. A beam hole in the container has an electric shutter with an effective working time of ~0.15 sec. Radiological protection and exact irradiation time were the chief design parameters. (auth)

7685 BOTTLING APPARATUS FOR NUCLEAR FUEL ELEMENTS AND THE LIKE. Burton, John Cornelius (to English Electric Co., Ltd.). British Patent 1,136,252. Dec. 11, 1968. Filed Jan. 22, 1965.

A bottling apparatus is described for use in filling and sealing bottles for holding irradiated matter such as nuclear fuel elements. Each bottle is an elongated thin-walled container, open at one end and having a seating in the open end and a separate end closure cap which can be sealed in the open end by deformation of the peripheral rim of the open end. The apparatus includes: a die for use in sealing the end cap, the die incorporating an annular locating portion adapted to engage around the open end of the container; a support arrangement to locate the container support directly in the die; a cap support, including a longitudinally projecting portion furnished with radially retractable balls and adapted to support an end cap on the balls. The apparatus can consist of a magazine of holders each having an open end portion, arranged on a common pitch circle, the magazine being rotatable between a number of positions in each of which a container holder can engage the die. The apparatus can further include a rotating and indexing arrangement for rotating the magazine successively to a first position, in which the container with a cap loosely supported can be inserted in the holder; a second position, in which the container is axially opposite the cap support device so that the latter can engage the cap and remove it longitudinally; a third position, in which the fuel element can be inserted in the container; then back to the second position for the cap to be replaced and sealed by the deformation of the peripheral rim of the container. (UK)

7686 SEALING OF METALLIC TUBULAR WORKPIECES. Durie, Philip Ian (to United Kingdom Atomic Energy Authority). British Patent 1,136,509. Dec. 11, 1968. Filed Nov. 15, 1965.

One of the most widely used types of nuclear reactor fuel element is that in which nuclear fuel material is sheathed in a protective tube closed at its extremities by end caps. Each of the two end caps is sealed to the sheath by a circumferential butt weld formed by an argon shielded arc welding process. The use of these welded end caps presents difficulties when the fuel elements are of small size in cross-section, such as those referred to as fuel element pins. These difficulties are associated with various factors, which include the need for precision in control of weld penetration, the desirability of minimising the zone affected by weld heat, the fact that abrupt changes in cross-section occur in the immediate vicinity of the weld, and grain growth in the welded components. A method is described for sealing a metallic tubular workpiece using a welding torch arranged transversely with respect to the axis of the workpiece, the workpiece being supported on either side of the torch, relative rotation being established between the torch and the workpiece, and an arc being struck between the torch and the workpiece; the speed of relative rotation is increased while the current fed to the torch is reduced, so that the workpiece is cut into two portions, at least one having a sealed end closure formed by recasting of the metal of the workpiece in the region of the arc. In order to smooth off the seal weld thus formed and to round off external and internal sharp corners between the seal weld and the main body of the workpiece it is preferable to perform a second weld run with the welding torch set at the edge of the seal weld. This second weld run is also carried out under reducing current conditions and increasing speed of rotation. (UK)

7687 METHOD AND APPARATUS FOR MACHINING GROOVES IN A TUBULAR MEMBER. (to Commissariat a l'Energie Atomique). British Patent 1,138,500. Jan. 1, 1969. Priority date June 30, 1965, France.

The equipment and method for machining helical grooves in tubular member to define helical fins are described. The tubular member is mounted in two rotatable chucks. Spindle supporting tools are mounted inside the tubular member. Blades are arranged in parallel planes and are inclined with respect to the longitudinal axis of the tubular member. While the tubular member rotates, radial displacement corresponding to the depths of the cuts to be made is provided. (F.S.)

7688 IMPROVEMENTS IN OR RELATING TO PUMPS. Stutely, John Richard; Walkden, Anthony John (to General Electric Co., Ltd.). British Patent 1,132,442. Oct. 30, 1968. Filed Sept. 2, 1965.

A form of pump is described which is designed particularly, but not exclusively, for pumping high temperature and/or corrosive fluids. An application is for pumping molten slag seed mixtures across pressure gradients up to 10 atm at temperatures between 1400° and 1800°C in a combined heat exchanger and seed recoverer of an MHD generator plant. The pump comprises a channel extending from a first region to a second region, and at least two passages or sets of passages communicating, by way of inlets, with the channel at positions spaced along the length and/or across the channel, and means for effecting phased pulsations of the fluid along the passages, the inlets being directed so as to induce a net forward flow of fluid along the channel from the first to the second region. Means may be provided to produce pulsations in a gas separated from the liquid to be pumped by a gas-liquid interface. Means to effect pulsations of the liquid may include an internal combustion chamber; and a thermal expansion chamber with means for periodically introducing a vaporisable drive liquid. Various adaptations of the system are covered. (UK)

7689 IMPROVEMENTS IN AND RELATING TO A HEAT EXCHANGER. Pouderoux, Pierre; Salon, Guy (to Commissariat a l'Energie Atomique). British Patent 1,138,940. Jan. 1, 1969. Priority date May 12, 1966, France.

Adaptations are described for fast reactor heat exchangers to allow heat transfer between two fluids which may react dangerously. The steam generator which is heated by liquid sodium consists of a number of unitary exchangers assembled in series or parallel. The unitary exchangers can be isolated for repair. Exchanger tubes are in the form of flat coils in parallel planes in a rectangular sheath suspended from a cover. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 7689, 7701, and 7702.

7690 (DLR-FB-67-85) THEORETICAL CONSIDERATIONS ON A VAPORIZATION COOLING SYSTEM WITH CAPILLARY DISTRIBUTOR. Quast, Armin (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Strahlantriebe). Dec. 20, 1967. 23p. (In German). Dep.

A vapor cooling system of high thermal efficiency is theoretically examined. The vaporized fluid is, as in heat pipes, kept on the cooling surfaces by open capillaries. The Mach Number and critical heat flux limit the heat transport of the vapor. A nuclear reactor equipped with thermionic power converters is shown as an example of the efficiency of the cooling system. At 650°C with potassium as the coolant, with a vapor Mach No. of less than 0.3 and a theoretical temperature difference between the reactor core and the reactor center point of less than 0.5°C, the pumping power required for the vapor cooling system is about one one-hundredth (1%) of that required for circulation of the liquid metal coolant. (tr-auth)

7691 (LA-4039) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING OCTOBER 31, 1968. PART I. (Los Alamos Scientific Lab., N. Mex.). Nov. 22, 1968. Contract W-7405-eng-6. 6p. Dep. CFSTI.

Fluid pressure conditions which can occur with annular return heat pipes using cesium, mercury, potassium, or sodium as the working fluid are described, and calculated values are compared with experimental measurements. (L.C.L.)

7692 (WERL-TAADM-1) DECAY HEAT TRANSFER FROM REACTOR FUEL RODS IN TEST HOLDERS IN A HOT CELL (LWBR DEVELOPMENT PROGRAM). Pieczynski, A. T.; Stewart, W. A. (Westinghouse Research Labs., Pittsburgh, Pa.). Sept. 23, 1968. Contract AT(11-1)-Gen-14. 59p. Dep. CFSTI.

For Bettis Atomic Power Lab., Pittsburgh, Pa.

Temperatures were measured on electrically heated models of nuclear fuel rods in three types of rod holders for the conditions obtained with various rates of decay heating when rods and holders rest horizontally or vertically on the floor of a hot cell. Theory describing the heat transfer by free convection and radiation inside and outside the holders is derived and tested. Fin conduction theory for heated and unheated fuel element lengths was derived and applied. Model rod emissivity was measured. Correlations of the data on the transfer from a single rod and from the holders agreed well with calculated results. The small fractions of heat transferred from holder to the floor and convected to air circulating through a holder were determined experimentally. Correlations for heat transfer with the holders and rods used by the Bettis Atomic Power Laboratory permit determination of the time when they may be removed to a hot cell without exceeding a prescribed temperature. (auth)

Isotope Technology

Refer also to abstracts 7640, 7673, 7681, 7684, 7707, 7708, 7907, 8132, 8340, and 8491.

7693 (EUR-4065) STUDY OF A METHOD OF FIXATION OF METHYL BROMIDE USED FOR DETECTING LEAKS IN GAS MAINS. Final Report. Caldera, P. G.; Pavesio, F.; Bruno, A. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)). May 28, 1968. 56p. (In French). Dep.

Experiments carried out to investigate a method of fixing radioactive methyl bromide (^{82}Br-labeled) which is used for detecting leaks in town gas mains are described. The method is based on the elimination of the gas tracer, by absorption or adsorption in selective filters, before the gas reaches the user. It has the advantage of not requiring the gas supply to be interrupted while leaks are being traced. A search of the specialized literature led to several chemical compounds that act as absorbers or adsorbers such as monoethanolamine, triethanolamine, pyridine and various types of active carbon. The most promising results were obtained with active carbon. The type of filter developed, which is positioned in the rising column, was tested in trials carried out both in the laboratory and in sections of underground pipe. Mixtures of methane and methyl bromide and of town gas and methyl bromide were used for this purpose. In addition tests were carried out to assess the diffusion of methyl bromide in premises where gas is consumed. (auth)

7694 (KURRI-TR-31) A USEFUL GAMMA-RAY SOURCE OF POWDERED ^{192}Ir FOR RADIOGRAPHICAL UTILIZATION. Tsujimoto, Tadashi; Sumino, Teruie; Katsurayama, Kosuke (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 4p. (In Japanese and English). Dep.

Radioactive materials for radiography should be small in volume and high in specific activity. Powdered radioactive isotope ^{192}Ir was produced by nuclear reactor irradiation for non-destructive testing. Experiments on the specific activities of gamma rays were performed for several geometries of cylindrical samples, with the same diameters and heights (1.5 to 5.0 mm long). The experimental results were one and one-half to three times as large as the calculated values which were evaluated on the assumption that the powdered iridium might be uniformly distributed in an arbitrary volume. The difference seems to be caused by the fact that the self-shielding effects of neutrons by the samples were smaller than the values used in the calculation, because the samples employed were composed of the particles with about 200 meshes. It may be seen that the gamma-ray source of the powdered iridium can be of practical use for the non-destructive testing. (tr-auth)

7695 (MMM-3691-39) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 9, July 1, 1968-September 30, 1968. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Oct. 1968. Contract AT(30-1)-3691. 149p. Dep. CFSTI.

EQUIPMENT AND PROCEDURES—testing of SNAP-21 power-conditioning
FUEL CAPSULES—fabrication of SNAP-21
PACKAGING—design of metal, for SNAP-21
PRESSURE VESSELS—fabrication and testing of Berylco 165, for SNAP-21
SHIELDING—testing of biological, for SNAP-21
SHIPPING—containers for SNAP-21, fabrication and testing of
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-21—assembly, processing, and testing of 10 W thermoelectric generators for
—design concept for 20 W thermoelectric generator for
TEMPERATURE—measurement of SNAP-21 shipping container
THERMAL INSULATION—development and testing of SNAP-21
THERMOCOUPLES—performance and testing of SNAP-21
THERMOELECTRIC CELLS—fabrication and testing of SNAP-21 (R.C.K.)

7696 (MMM-3824-27) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 7, July 1-September 30, 1968. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Oct. 31, 1968. Contract AT(30-1)-3824. 97p. Dep. CFSTI.

Initial performance testing, stability conditioning, and contract specification were completed on the Prototype Mock-up Converter (PMC-1A). Testing indicated an efficiency greater than design objectives. Parts were machined and processed for PMC-1B. Test data evaluation and analysis continued on test devices Experimental Mock-up Converter No. 2 (EMC-2), and No. 3 (EMC-3), 10-Couple modules No. 1, 3, 5 through 12, Converter 23 P-2, and 6-Couple Module 23 A-3. Ten-Couple modules, Nos. 2 and 4, have been removed from test after 8264 and 8242 test-hours for post-test analysis. (J.C.W.)

7697 (ORNL-4338) EVALUATION OF FOUR METHODS USING ^{198}Au FOR SURFACE LABELING SAND AND A NEW TECHNIQUE FOR SIMULATING MASS LABELING. Stephens, Nancy H.; Acree, E. H.; Case, F. N. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 9p. Dep. CFSTI.

Procedures for tagging sand with ^{198}Au to be used in the study of sediment transport have been reported but not in sufficient detail to permit their use in obtaining reproducible results or to provide information concerning the characteristics of the labeled sand. Therefore two methods that were reported, one using direct reduction by stannous chloride and the other using displacement of silver with gold, were selected for further study. Two new techniques, based on direct labeling and reduction-displacement by using p-isopropylbenzaldehyde, were devised. The four methods were compared with respect to overall tagging efficiency and adherence of the gold to the sand after the samples were subjected to water leaching and mechanical abrasion. The most effective method was the one based on direct labeling using p-isopropylbenzaldehyde. This method was also adapted to simulate mass labeling; that is, the sand was labeled in such a way that the number of radiation counts detected per unit weight of sand appeared to be proportional to mass rather than to surface area. (auth)

7698 (SC-RR-68-529) COMPUTER CODE HRS015: A QUIKTRAN COMPUTER CODE FOR THE COMPUTATION OF THE TRANSITION FLOW HYPERSONIC BALLISTIC COEFFICIENT OF A BLUNT OBJECT. Spahr, H. R. (Sandia Labs., Albuquerque, N. Mex.). Oct. 1968. 50p. Dep. CFSTI.

In the Aerospace Nuclear Safety Program, safety analyses are required to determine the behavior of nuclear systems during launch aborts after liftoff and reentry after use in space. These analyses require theoretical trajectories to define the aerothermodynamic history of the reentering nuclear system and attached hardware. Before the required trajectories can be computed, the hypersonic ballistic coefficient of the reentering nuclear system and attached hardware must be defined. The required trajectories start at high altitudes where the reentering object is in the free molecule flow regime, subsequently pass through the transition flow regime, and terminate in the continuum flow regime. Thus, the hypersonic ballistic coefficient of the reentering object must be defined in the free molecule, transition, and continuum flow regimes. The QUIKTRAN computer code HRS015 developed by the Reentry and Space Sciences Division of Sandia Laboratory's Aerospace Nuclear Safety Department is described. This computer code calculates the variation of the hypersonic ballistic coefficient of an object with altitude. (auth)

7699 NEUTRONIC DEVICE. Hill, Robert F. (to General Motors Corp.). U. S. Patent 3,401,083. Sept. 10, 1968. Filed Feb. 2, 1967.

A method is described for providing a very thin, fissionable layer of ^{235}U-enriched U-Ni alloy on a tantalum element of a neutronic device for use in supplying ionization radiation in thermionic converters, nuclear reactors, and the like. (L.C.L.)

7700 SELF-LUMINOUS LIGHT-EMITTING UNITS. Clapham, Charles H. Jr. (to United States Radium Corp.). U. S. Patent 3,409,770. Nov. 5, 1968. Filed Sept. 28, 1964.

A self-luminous light-emitting unit is described. A sealed glass element is filled with a radioactive gas and coated interiorly with a film substantially of phosphoric acid on which is adhered and exposed a particular phosphor. The element is embedded in shock absorbent transparent elastomeric potting materials in a cavity formed in the transparent body within which light passes without substantial diffusion. The cavity is coated with reflective white paint everywhere except at a window area on its front face. (Offic. Gaz.)

7701 JET CONDENSER PERFORMANCE WITH ORGANIC RANKINE-CYCLE POWER SYSTEMS. Garcia, R. (Aerojet-General Corp., Azusa, Calif.). pp 183-91 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

Jet condenser assemblies using Dowtherm A (eutectic mixture of biphenyl and biphenyl ether) as the working fluid have been designed to operate at a vapor inlet pressure of 0.1 psia. The subcooled liquid is introduced at a temperature 50° or 75°F below the vapor temperature. The jet condenser assemblies were fabricated and subjected to hydraulic testing. The 75°F unit exhibited a pressure recovery of 68%, while the 50°F unit achieved a 57% pressure

recovery. Hot-gas testing of the jet condensers in the modified ORACLE power conversion system has demonstrated the feasibility of operation at an inlet pressure of 0.2 psia, which would result in overall system efficiencies greater than 20% for a rotating organic Rankine-cycle power conversion system. (auth)

7702 ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM: A STATUS REPORT. Adam, A. Warren; Niggemann, Richard E. (Sundstrand Aviation, Rockford, Ill.). pp 192-9 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

Two candidate organic working fluids are being investigated at Sundstrand for potential use in a Rankine Cycle Power Conversion system for space applications. They are biphenyl and the eutectic mixture of biphenyl and phenyl ether. The thermal stability, heat transfer characteristics and lubricating qualities of the fluids are being determined. Four thermal stability test loops have been built and are being operated at turbine simulator inlet temperatures of 650° and 700°F. Operating times of over 3800 hours have been accumulated as of January 1, 1968. Results of detailed analyses of the fluids indicate excellent stability. A radiation boiler test rig, a bearing test rig, and a pump test rig have been built and testing initiated. (auth)

7703 NUCLEAR INDUSTRY 68. PART II. OTHER NUCLEAR INDUSTRIES. Nucl. News, 12: 38-42(Jan. 1969).

The 1968 status of the production and uses of radioisotopes is discussed. The principal uses include thermoelectric generator heat sources, commercial irradiation and testing, and biomedical and medical applications such as diagnosis, research, and treatment. Commercial use of radioisotopes for food irradiation has suffered a setback due to the FDA withdrawal of its approval of irradiated bacon. The demand for radiochemicals, radiopharmaceuticals, and both cyclotron- and reactor-produced radioisotopes continues to grow at rates exceeding 10% per year. The dollar values for growth in particular applications are given. (L.C.L.)

7704 MEASUREMENT OF MOISTURE IN RAW MATERIALS IN IRON-MAKING FACILITIES. Makabe, Eichi. Otomeshon, 13: No. 8, 32-7(Aug. 1968). (In Japanese).

Methods for making moisture measurements in iron-making facilities are discussed. The object of moisture measurement is the economic efficiency brought about by improvement in quality, stabilization of operations and rise in yield rate. A neutron moisture meter is used. In the neutron moisture meter, fast neutrons are radiated from a Am–Be radiation source, and thermal neutrons scattered and reflected by the sample are counted, and the information on the number of hydrogen atoms is obtained. A BF_3 tube is utilized as the detector of thermal neutrons. The moisture meter has the characteristic values of equivalent moisture rate, volumetric specific weight, effective volume, and the effects of specific elements. Therefore, when the neutron moisture meter is installed on-line, the place of installation must be decided, taking these characteristics in consideration. The actual status of on-line measurements of moisture in coke is presented. (NSA of Japan)

7705 INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Taylor, K. J. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Rep. Progr. Appl. Chem., 52: 243-56(1967).

Progress in this field during 1966 to 67 is reviewed, the main emphasis being on the development of radioisotope techniques in analysis and tracing. Main headings are as follows: Activation analysis; lithium-drifted germanium detectors; trace boron in metals and solids; X-ray fluorescence analysis; tracer applications; hydrology. Thirty references are quoted, and a supplementary bibliography is included under the headings: Analysis, process control; tracer applications; hydrology; instruments and techniques; radiography and autoradiography; general articles and power development. (UK)

7706 RADIOISOTOPE GENERATOR. (to North American Aviation Inc.). British Patent 1,138,310. Jan. 1, 1969. Priority date June 17, 1965, United States.

A radioisotope-powered generator with reduced neutron shielding is described. The generator may be used to supply power for space ship instruments; remote unattended long-lived small power sources e.g., communication relay stations, forest warning equipment, and ocean cable boosters; and cardiac pacemakers. The method for preparing the $^{238}Pu\ ^{16}O_2$ fuel is given. (F.S.)

Materials Testing

Refer also to abstracts 7672 and 8166.

7707 (AAEC/TM-460) RADIOGRAPHIC EXPOSURE CHARTS FOR RADIOISOTOPE SOURCES. Gillespie, P. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1968. 18p. Dep.

Radiographic exposure charts prepared for cobalt-60, cesium-137, cesium-134 and iridium-192 with steel, and for thulium-170 with aluminum, are presented as a practical guide for the radiographer. Experimental procedures used in compiling the charts are described and a summary is given of the factors influencing exposure time. (auth)

7708 (BNWL-SA-2111) ULTRASONIC TEST SUPPORT FOR CONTAINER INTEGRITY ASSURANCE. Steffens, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 23, 1968. Contract AT(45-1)-1830. 24p. (CONF-680929-1). Dep. CFSTI.

From AIME Nuclear Metallurgy Symposium, Oak Ridge, Tenn.

Ultrasonic nondestructive testing techniques can be used to establish the container integrity of fueled isotope capsules. The ability of ultrasound to detect close fitting cracks, and to obtain complete inspection of the container volume, was found to supplement the information normally acquired through radiographic, dye penetrant, and metallographic analysis. The ultrasonic inspection of the raw material quality and establishment of basic ultrasonic techniques are discussed. Adequate weld parameter characterization and the subsequent assurance of weld testability on the fuel capsule are described. Radiographic and metallographic analyses are used extensively during the ultrasonic test development phase to verify the ultrasonic test results. The results must be standardized and calibrated. The remote ultrasonic verification of the integrity of fueled SNAP-21 capsules illustrates the effectiveness of applying a cooperative approach between capsule fabrication and NDT personnel to assure capsule certification. (J.C.W.)

7709 (CEA-CONF-1070) METHOD OF ULTRASONIC CONTROL OF THIN TUBES PERMITTING SEPARATE RECORDING OF INTERNAL AND EXTERNAL LONGITUDINAL DEFECTS. Chretien, J. F.; Huard, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 15p. (In French). (CONF-680606-7). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

When a new manufacturing process is brought out it is important to have all the information possible concerning any defects in the finished product, in order to act with maximum efficiency on the techniques employed. Especially in the case of tubes intended for the cladding of fuel elements, where a very high quality is required, it is extremely useful to know where the defects are located with respect to the outer and inner walls of the tube. The characteristics of the commercial instruments commonly used for ultrasonic testing of this type of tube are such that no distinction can be made between internal and external defects by the use of conventional methods. A method was developed based on differences in the damping of LAMB waves at the air-metal and metal-water interfaces. This technique may be used with any standard ultrasonic apparatus provided it possesses an amplifier with variable gain along the time base. It has been used successfully for the pre-series testing of zirconium–copper cladding of thickness varying between 0.7 and 1.2 mm. It has also been used for stainless steel tubes of 6.3 mm dia and 0.35 mm thick. (auth)

7710 (CEA-CONF-1074) DETECTION OF WELD DEFECTS OPENING ONTO THE SURFACE THROUGH USE OF AMMONIA GAS. Chretien, N.; Chretien, J. F.; Cortely, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 41p. (In French). (CONF-680606-5). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

A new method, based on ammonia sweating, has been perfected for the detection of surface defects in welds. The process consists of three operations: first the container surrounding the zone to be tested is evacuated; then this container is placed under ammonia pressure; and finally, after a return to atmospheric pressure, a reactive paint is applied to the specimen. Very clear patches then appear on the points showing where defects emerge at the surface such as flaws, cracks, pores, etc. (auth)

7711 (CEA-CONF-1082) CONTROL OF THE PHENIX REACTOR CANS BY ULTRASONICS; DESCRIPTION OF THE EQUIPMENT. Prot, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 13p. (In French). (CONF-680606-13). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

The fast neutron reactor PHENIX has two types of fuel elements; the core elements which can burn up, and the cover ele-

ments which are fertile. It is essential, if the reactor is to operate satisfactorily, that the cans for these two types of elements be without defects. Ultrasonic testing is one of the methods which has been chosen for examining the quality of the can tubing. The machine which has been developed for carrying out this control is described, as well as the interference which may exist between the required quality level (limiting detectable standard flaw) and the characteristics of the control device. (auth)

7712 (NP-tr-1716) IMAGE ANALYSIS OF THERMAL NEUTRON RADIOGRAPHS. Inouye, T.; Ogawa, K.; Iwanaga, M. Translated by R. A. Scott (Atomic Energy Research Establishment, Harwell, Eng.), from Oyo Butsuri, 34: 801-6(1965). 15p. Dep. CFSTI.

Images obtained in thermal neutron radiography by the use of a small nuclear reactor are analyzed by the technique of Fourier analysis. The optical transfer functions for a non-parallel neutron beam and for the process of image transfer from an activated In film to an x-ray film are derived and compared with experiment. The spurious resolution of image expected from the shape of the optical transfer function is observed. (auth)

7713 IMPROVEMENTS IN OR RELATING TO ULTRASONIC TESTING APPARATUS. Hanstock, Raymond Ford (to United Kindgom Atomic Energy Authority). British Patent 1,137,301. Dec. 18, 1968. Filed Nov. 15, 1965.

An irrigated ultrasonic probe unit (for detecting flaws in metal plates, for example) is described, having an open chamber with inlet and outlet ports for liquid coupling of the probe unit and having magnetic means for holding the probe unit against a test piece. Means for sealing the chamber to the test piece are provided. (UK)

Radioactive Material Handling

Refer also to abstract 7896.

7714 (KURRI-TR-19) STUDIES ON REMOVAL OF FISSION PRODUCT BY FLOTATION METHOD: REMOVAL OF Ce. Koyanaka, Yoshio (Kyoto Univ. (Japan). Research Reactor Inst.). June 20, 1966. 7p. (In Japanese and English). Dep.

Flotation has proven to be effective in removing Ce from its aqueous dilute solution with the aid of suitable coprecipitant such as ferric or cobalt hydroxides and flotation collector such as sodium oleate. Experiments on single stage flotation proved that 90 to 90% of Ce can be removed by optimum choice of the concentration of coprecipitant and collector, and that the pH of flotation medium and the amount of radioactive sludge is much less than the amount of sludge which is required in chemical flocculation method. Multiple flotation for four successive stages gave decontamination factors of 10^3 to 10^5 with a volume reduction ratio of higher than 100. (tr-auth)

7715 (KURRI-TR-21) STUDIES ON REMOVAL OF FISSION PRODUCT BY FLOTATION METHOD: REMOVAL OF ^{106}Ru. Koyanaka, Yoshio (Kyoto Univ. (Japan). Research Reactor Inst.). June 20, 1966. 5p. (In Japanese and English). Dep.

The removal of ^{106}Ru has been studied using the technique of soap flotation. Flotation is effective in removing ^{106}Ru from its dilute aqueous solution (10^{-2} μc/ml) with the aid of coprecipitant such as ferric or cobalt hydroxide and a collector such as sodium oleate. In experiments on single stage flotation, 98% of ^{106}Ru were removed by optimum choice of reagent conditions. Multiple flotation for four successive stages gave decontamination factors of 10^3 to 10^5 with a volume reduction ratio of higher than 100. (tr-auth)

7716 (KURRI-TR-24) STUDIES ON REMOVAL OF FISSION PRODUCT BY FLOTATION METHOD: REMOVAL OF ^{95}Zr-^{95}Nb. Koyanaka, Yoshio (Kyoto Univ. (Japan). Research Reactor Inst.). June 20, 1966. 11p. (In Japanese and English). Dep.

The removal of ^{95}Zr-^{95}Nb by the flotation method was studied. It has been found that 98 of ^{95}Zr-^{95}Nb can be removed from aqueous dilute ^{95}Zr-^{95}Nb solution (6.0×10^{-5} μc/ml) by single stage flotation. Multiple flotation for three or four successive stages gave decontamination factors of 10^3 to 10^4. (tr-auth)

7717 (ORNL-TM-2302) ANALYSIS OF THE OAK RIDGE NATIONAL LABORATORY DRY HOLE CHARGER SHIPPING CASK. Evans, J. H. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 86p. Dep. CFSTI.

An analytical evaluation of the ORNL Dry Hole Charger Shipping Cask was made to demonstrate its compliance with the regulations governing packages in which radioactive material is shipped. Computational procedures were used to determine the structural integrity and thermal behavior of the cask with respect to the general standards for packaging, structural standards, standards for normal conditions of transport, and the standards for the hypothetical accident conditions. The results of this evaluation show that the cask complies with all the applicable regulations. (auth)

7718 APPARATUS AND METHOD FOR RETAINING RADIOACTIVE EXHAUST GAS. Yamanouchi, Hajime (to Hitachi, Ltd.). U. S. Patent 3,400,511. Sept. 10, 1968. Priority date Dec. 28, 1962, Japan.

A process is described for treating an exhaust gas containing radioactive gases. The process selectively directs exhaust gas of low radioactivity directly to the atmosphere and exhaust gas of high radioactivity to the first of a series of adsorption reservoirs which substantially remove the radioactive gases from the exhaust gas in this adsorption reservoir, discharges the treated exhaust gas to the atmosphere, and monitors the discharged gas so that when the radioactivity of the gas reaches a predetermined level, the first adsorption reservoir is bypassed and the exhaust gas containing radioactive gases is directed to a second reservoir and succeeding reservoirs as the adsorbing capacity of each reservoir is in turn spent. (auth)

7719 RADIOACTIVE PACKAGE AND CONTAINER THEREFOR. (to E. R. Squibb and Sons, Inc.). British Patent 1,136,194. Dec. 11, 1968. Priority date Apr. 6, 1966, United States.

A column for radioactive material which is enclosed in a shielded container designed so that sterile eluate obtained from the column may be removed without removing the column from the shielded container is described. The column consists of a hollow body closed at the bottom and top by a pierceable closure. The shielded container has an aperture at the bottom located at the column bottom closure. The container is fabricated of γ shielding material. Limited access to the container is provided at the top. (F.S.)

7720 REMOTE HANDLING DEVICE. Fortin, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,136,585. Dec. 11, 1968. Priority date June 11, 1965, France.

A small remote handling device is described which ensures accurate operation, permits displacement of the grab without untimely opening, and is simple in design and operation. Leaktightness through a wall is ensured. The device consists of a controlled unit coupled to a control mechanism by a motion transmission system which provides rotational and translational movement. The device is useful in manipulating radioactive objects in the tank of a swimming pool reactor or in a hot cell. (F.S.)

7721 IMPROVEMENTS IN OR RELATING TO TRANSPORT CONTAINERS FOR RADIOACTIVE MATERIAL. Scott, Charles John Meldrum; Wells, Henry (to United Kingdom Atomic Energy Authority). British Patent 1,135,496. Dec. 4, 1968. Filed Nov. 23, 1967.

The container described comprises an inner vessel of dense radiation resisting material (e.g., lead) and an outer casing of sandwich construction, with inner and outer skins, enclosing a thermoinsulating core material. The insulating material may, for example, be a resin-bonded particulate, such as wood flour, and the skins moulded from fire-resistant polyester resin/glass fibre or from long fibre asbestos and an epoxy resin. The container can take the form of a pair of dome-shaped shells coengaging to form a closed vessel. (UK)

7722 IMPROVEMENTS IN OR RELATING TO THE INJECTION OF RADIO-ACTIVE WASTE INTO THE EARTH. (to Commissariat a l'Energie Atomique). British Patent 1,137,849. Dec. 27, 1968. Priority date Mar. 30, 1965, France.

An improved method for injecting radioactive wastes into the ground is described. The method permits an increased amount of waste to be injected in a single operation. A slurry is formed of the waste, cement, aldehyde, and resorcinol. The aldehyde and resorcinol form a phenoplastic resin which retains the decantation water in the mixture. (F.S.)

7723 ACCELERATED DEFORMATION OF ROCK SALT AT ELEVATED TEMPERATURE AND PRESSURE AND ITS IMPLICATIONS FOR HIGH LEVEL RADIOACTIVE WASTE DISPOSAL. Lomenick, Thomas Fletcher. Knoxville, Tenn., Univ. of Tennessee. 126p.
Thesis.

With the storage of high-level radioactive waste in salt structures, unique mine stability problems will occur as a result of the elevated temperatures. To predict flow in rock salt, scale models of salt pillars and their surrounding rooms were fabricated from cores taken in the Carey salt mine, Lyons, Kansas. Tests were conducted at temperatures of 22.5°, 60°, 100°, and 200°C for axial loads of 2,000, 4,000, 6,000, 8,000, and 10,000 psi at each temperature. These tests showed that marked increases occur in the rates of deformation of salt pillars at high loads and

especially at elevated temperatures. For all combinations of axial loads and temperatures, it was observed that there is initially a high rate of deformation that diminishes with time. Creep rates were found to continue to decrease even after more than 3 years of testing. An empirical relationship between pillar deformation, stress, temperature, and time was developed from the tests and is expressed as $\dot{\epsilon} = 0.39 \times 10^{-37}\ T^{9.5}\ \sigma^{3.0}\ t^{-0.70}$, $\epsilon = 1.30 \times 10^{-37}\ T^{9.5}\ \sigma^{3.0}\ t^{0.30}$, where $\dot{\epsilon}$ = strain rate (in./in./hr.), ϵ = cumulative deformation (in./in.), T = absolute temperature (°K), σ = average pillar stress (psi), and t = time (hr.). For comparative purposes, model pillar tests were conducted on samples of bedded salt, as well as on dome salt from six different mines in the United States and from the anticlinal structure of the Asse II salt mine in Northeast Germany. In general, the deformational behavior for the various types of salt was similar at room temperature as well as at elevated temperature even though some variations in the rates of deformation were observed. From model tests it was also observed that greatly accelerated rates of deformation will occur in excavated cavities where thin shale beds occur in the pillars at the roof and floor interfaces. Since the shales serve as friction reducers, effective confining stresses in the roof and floor are not transmitted into the pillars; thus the pillars under these conditions are weaker than where shale partings are not present at the tops and bottoms of the pillars. (Diss. Abstr.)

Vacuum Engineering

Refer also to abstract 9138.

7724 IMPROVEMENTS IN OR RELATING TO MAGNETICALLY CONFINED ELECTRIC DISCHARGE APPARATUS. (to Nihon Shinku Gijutsu Kabushiki Kaisha). British Patent 1,130,145. Oct. 9, 1968. Priority date Dec. 30, 1964, Japan.

A magnetically confined electric discharge apparatus is described including a casing adapted to be evacuated. Within this casing ionization in the gas phase is required in the operation of the apparatus. Anode and cathode electrodes are arranged within the casing to define an ionization region. A radioactive source is located within the casing, as is a means for cooperating with the radioactive source in operation of the apparatus in order to derive a stream of ionizing electrons therefrom. The electrons are to be within the ionization region of energy appropriate to their being confined between the electrodes in the ionization region by a magnetic field. The cooperating means includes a target for emission of secondary electrons after bombardment by radiation from the radioactive source. Applications particularly concern but are not limited to getter ion pumps and glow discharge vacuum gages. (M.H.R.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 7578, 7673, 7676, and 8020.

7725 (AERI–22) DEVELOPMENT OF RADIATION COUNTER FOR DOMESTIC PRODUCTION. Park, In Yong; Ahn, Byung Sung (Atomic Energy Research Inst., Seoul (South Korea)). Aug. 1968. 66p. (In Korean and English). Dep.

The results of developmental experiments carried out on a few types of radiation counting equipment e.g., the linear amplifiers, the pulse height analyzers, the high voltage supplies and the NaI(Tl) photomultiplier assembly are described. Three models were built and tested. All of the circuits are composed of semiconductor devices so that power consumptions are low. The current mode input circuits are used for the purpose of excluding preamplifier in photomultiplier assemblies. (auth)

7726 (CEA-Bib–122) STUDY OF IONOGRAPHIC TRACKS IN INSULATORS. LITERATURE SURVEY. Thomas, Jean-Jacques; Teyssier, Jean-Louis (Toulouse Univ. (France). Centre de Physique Atomique et Nucleaire); Chapuis, Anne-Marie; Francois, Henri (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). July 1968. 98p. (In French). Dep.

A literature survey of results published before 1967 on the detection of ionizing particles in solids is presented. The different modes of observation and of chemical development of these tracks and the criteria proposed for classifying the detector materials as a function of their sensitivity are described. A brief review of the hypotheses which make it possible to explain partially the mechanism of formation of tracks is included. The description of these detectors is limited to those liable to find applications in nuclear physics (spallation and fission reactions, cross-section measurements, neutron dosimetry) and in geophysics (study of fossil tracks in natural ores of terrestial or extra-terrestial origin). (auth)

7727 (CEA-Bib–131) TRITIUM IN HEALTH PHYSICS. Charamathieu, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 104p. (In French). Dep.

Tritium is a soft β emitter which occurs most commonly either in elementary form or as tritiated water. In this latter case its radio-toxicity is much higher. The sampling, detection and measurement methods vary according to the physico-chemical state in which the element occurs. Numerous methods have been developed. The protection of the personnel having to work in contaminated atmospheres is complicated by the fact that on top of its high radio-toxicity, tritiated water is very easily absorbed by the skin and the mucous tissues and diffuses quicker than tritium through the polymerized or rubberized materials used in the manufacture of protective clothing. It has thus been necessary to find materials having a low permeability coefficient for tritiated water and which can be used to make protective clothing whose design and impermeability will have been particularly studied. A survey is presented with 205 references. (auth)

7728 (CEA-R–3460) COUPLING OF A REAL TIME COMPUTER TO NUCLEAR DETECTORS SYSTEMS. Lugol, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1968. 106p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Orsay, France.

Electronic computers are now included in nuclear physics experiment systems. This corresponds to a general trend to replace conventional multichannel analyzers by on-line real time computers. An on-line computer performing nuclear data acquisition and storage offers the advantage of reduction and calculation routines in real time. This advantage becomes a need when the number of experimental parameters increase. At the Saclay variable energy cyclotron a C 90-10 computer of C.I.I. is used. The input/output hardware features are described. In order to establish a dialog with physicists, a main display unit able to control many display consoles at different points was built. They are described as well as some utility routines. (auth)

7729 (CEA-R–3617) DETECTION OF THE CONTAMINATION OF AIR BY TRITIATED WATER VAPOUR AROUND THE REACTOR EL 3. Lebouleux, Philippe; Ardellier, Andre; Valero, Saby (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 43p. (In French). Dep.

The apparatus used for the detection of the tritiated water vapor contamination in the air around the reactor EL 3 is described. The apparatus consists of two air-circulation ionization chambers; the air in one of these is dried by passage through a silica-gel column. By carrying out a differential measurement of the ionization currents, it is possible to measure the tritiated water vapor concentration. A theoretical study of the response of the chambers is carried out for two types of emission of the tritiated water vapor: continuous, or in bursts. The experimental work comprises calibration in the measurement range employed; study of the selectivity for other active gases; study of typical accidents; and interpretation of the results in the case of discontinuous emission, taking into account the desorption from the walls of the measurement chamber which is observed during the emptying process. Examples of how to use the results are given. The apparatus makes it possible to detect, in less than ten minutes, contamination by tritiated water vapor in the presence of other active gases, in a measurement range of between 3 and 2 200 MPC, and with an accuracy of about 25 per cent. (auth)

7730 (CEAL–1045) CEA SECONDARY EMISSION MONITORS. Dell, George F.; Fotino, Mircea (Cambridge Electron Accelerator, Mass.). Nov. 4, 1968. Contract AT(30-1)-076. 39p. Dep. CFSTI.

The response of aluminum and gold secondary emission monitors has been measured from 1.5 to 18 GeV for electrons and at 6 and 11 GeV for positrons. The secondary electron yield in a positron beam was found to be 1 to 3% larger than in an electron beam. Dependence of SEM response on the angle of the beam from normal incidence was found to vary as $\sec\theta$. For energies below 8 GeV, the response of both types of monitors varies nearly as ln(E). However in the range 1.5 to 18 GeV, the deviation from a ln(E) dependence is 6.8% for gold and 31% for aluminum. Attempts of correlating the measured energy response to the theory of Vanhuyse and Van de Vijver indicate that the yield slope (predicted to be independent of energy) varies by nearly an order of magnitude in this energy range. A departure of SEM response from a ln(E) dependence is predicted by the theory of Aggson. Use of an interaction energy of $\eta = 10^4$ produced a more pronounced deviation than is evident from our data. Based on the argument that the ln(E) dependence results from distant collisions, η was varied to include values that are more realistic for these distant collisions, and reasonable fits to the data were obtained for $0.01 \leq \eta \leq 0.1$ eV. A further test of Aggson's theory was made by measuring the response of a SEM in which the foil spacing could be varied. It was found that the monitor response increased with decreasing foil spacing. This is contrary to the predictions of Aggson's theory. Finally mention was made of the theoretical treatment of Bakhshyan and Garibyan in which the energy dependence of SEM's is attributed to the presence of a thin dielectric layer on the foil surfaces. Whereas Aggson predicts that the energy dependence results from the upstream foil surfaces and that departure from a ln(E) dependence is a consequence of finite foil spacing, Bakhshyan and Garibyan assert that the energy dependence results either from the total absence of the density effect in thin dielectric layers or at least from an increase in the energy at which the density effect becomes significant in thin dielectric layers. Tests of these assertions are still to be made. (auth)

7731 (CONF-681017–14) A LOW LEVEL ENVIRONMENTAL RADIATION MONITOR WITH HIGH SENSITIVITY, STABILITY, AND DYNAMIC RANGE. Cassada, Thomas E. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Oct. 1968. 9p. Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

An environmental radiation monitor is described which records gamma radiation levels with a logarithmic response over a dynamic range of four decades (0.01 mR/hr to 100 mR/hr achievable without range switching). Constant temperature accuracy is greater than ±10% of indicated reading throughout 3.5 decades of the four decade range. A high degree of temperature stability is achieved (error due to temperature change is less than ±20% of reading over an ambient temperature range of −10°C to +55°C). Solid-state electronic circuitry is utilized exclusively for increased reliability and long term stability. (auth)

7732 (EEMTIC–67-2-2) INSULATED-GATE FIELD-EFFECT TRANSISTOR IN ELECTROMETER APPLICATIONS FOR HIGH-RANGE RADIACMETERS. [nd]. 9p. (CONF-670124–1). Dep.

From Electrical and Electronic Measurement Test Instrument Conference, Ottawa, Ontario.

Design and performance of an insulated-gate field-effect tran-

sistor for use as a battery-operated dc amplifier for a high-range ionization chamber for gamma detection are presented. (W.H.K.)

7733 (EEMTIC-67-3-1) ADVANCES AND TRENDS IN RADIATION MONITORING. Sebok, Louis S. (Tracer Lab, Waltham, Mass.). [1966]. 26p. (CONF-670124-2). Dep.

From Electrical and Electronic Measurement Test Instrument Conference, Ottawa, Ontario.

General system and equipment requirements for a typical power reactor and a recently built floating nuclear power plant are discussed. Typical new commercially available personnel monitoring products are described, then advanced plant and environment and effluent monitoring systems are discussed, such as area monitoring, gas-, airborne particulate-, and liquid monitors. Telemonitoring adaptations and different advanced monitoring applications besides reactors are described such as irradiation facilities and accelerators with brief reflection on future developments. (auth)

7734 (GEPP-44) EFFECTS OF TEMPERATURE ON ORGANIC PLASTIC SCINTILLATORS. Salem, R. J. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Sept. 19, 1968. Contract AT(29-2)-656. 15p. Dep. CFSTI.

The effects of temperature on two similar plastic scintillators, Pilot B and Pilot-M, are given. The neutron detection efficiency of scintillators is reduced when exposed to excessive temperature (>135°F) for prolonged periods of time. Temperature sensitivity tests show that a permanent shift in the level of $\bar{Q}$ occurs between 127°-137°F for the Pilot-B scintillator and between 169°-179°F for the Pilot-M scintillator. $\bar{Q}$ is a ratio of the integrated fluor output pulse for a test detector to the integrated fluor output pulse for a standard detector. Differential thermal analyses show that the molecular structure of the fluor is changed drastically between 122°-144°F for the Pilot-B scintillator and between 164°-182°F for the Pilot-M scintillator. (auth)

7735 (IN-1255) QUALITY CONTROL PROGRAM FOR COUNTING INSTRUMENTS AND TECHNIQUES USED IN THE RADIO AND SPECIAL ANALYSIS LABORATORY. Quarterly Report, January 1-March 31, 1968. Brothers, J. W.; Hill, A. C.; Wilcox, C. M.; Scott, J. G. (Idaho Nuclear Corp., Idaho Falls). Nov. 1968. Contract AT(10-1)-1230. 50p. Dep. CFSTI.

The first quarterly report of the Quality Control Program for Counting Instruments and Techniques Used in the Radio and Special Analysis Laboratory is presented. Sources of Pu-239 and UX_2 were counted respectively with the gross-alpha and beta counters. Single nuclides including Cs-137 and I-131 were analyzed using the NaI(Tl) detection system. A mixed source of I-131, Te-I-132, Te-129, Cs-137, and Ru-103 was analyzed using the SHIFTY III computer program for calculation of the NaI(Tl) spectral data. A mixed source of Ce-Pr-144, Ru-106, Cs-137, and Zr-Nb-95 was analyzed by gamma nullification of NaI(Tl) spectral data using a ND-180, 512-channel analyzer. (auth)

7736 (JINR-P2-4145) INTERFERENTIAL EFFECTS WHILE REGISTERING PAIRS OF UNSTABLE PARTICLES. Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 17p. (In Russian). Dep.

General formulae are obtained for the probability of registration of the pairs of unstable particles and the resonances in the correlation experiments. It is shown that while registering, by one detector, the decay products of two particles with equal conserved quantum numbers the interference takes place which depends on the inherent flight time of particles and is connected with the non-orthogonality of the inner wave functions. (auth)

7737 (RFP-893) METHOD FOR PREDICTING SUBJECT BACKGROUND FOR IN VIVO PLUTONIUM MEASUREMENTS. Bistline, Robert W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 19, 1968. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

In vivo plutonium measurements in liver and chest are made in the Rocky Flats body counter using ^{241}Am as a tracer. Measurements are made using the 35- to 64-keV band which includes the 60-keV photon of ^{241}Am. Data obtained from 202 subjects show that background counts were contributed by room background, scatter radiation, and the ^{137}Cs and ^{40}K in the individual's body. The difference in counts from one person to another in this energy range was most affected by the scatter radiation. The background counting rate for a person can be predicted by an exponential function where height and weight reflect the difference in body volume and shape. (auth)

7738 (WAPD-Trans-102) MEANS OF DETECTING AND PROTECTING AGAINST TRITIUM. Sutra-Fourcade, Yves (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from report CEA-R-3350. 100p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 23262. (W.H.K.)

7739 SCINTILLATION GUARD DETECTORS FOR LOW-ACTIVITY BETA MEASUREMENTS WITH GEIGER-MUELLER COUNTERS. Williams, D.; Whittle, N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E (London), 2: 107-9 (Jan. 1969).

The design of compact plastic-scintillator guard detectors for low background beta measurement is described. Their performance is compared with other available guard detectors, and background count-rate reductions are demonstrated. The demountable assemblies for 1 and 2 in. window Geiger-Mueller counters can be readily manufactured and are arranged to fit standard photomultiplier housings. Typical backgrounds with 4 in. lead shields are 0.5 counts per minute for the GM4LB and 4.9 counts per minute for the 2B2. (auth)

7740 CONTRIBUTION TO THE DOSIMETRY OF THE FLUENCE OF THERMAL NEUTRONS. Maurette, M. (Faculte des Sciences, Paris); Mory, J. Rev. Phys. Appl., 3: 209-15 (Sept. 1968). (In French).

The recording of fission fragment trajectories in glass and mica and of α particles in cellulose nitrate has been used for the measurement of thermal neutron fluxes. A series of very cheap dosimeters, calibrated at $\pm 10\%$ for the measurement of absolute flux values between 10^6 and 10^{21} n/cm^2 have been realized; in this range of fluxes, the dosimeters can provide relative flux values with great accuracy. (auth)

7741 THIN-FILM DETECTOR FOR ATOMIC HYDROGEN BEAMS. Macfarlane, J. C. (Univ. of Chippendale, Australia). Vacuum, 18: 655-6 (Dec. 1968).

Existing techniques for detecting atomic hydrogen in beam experiments may be unsatisfactory when the detector is unavoidably exposed to the thermal and ultra-violet radiations from the dissociator, and to residual gases in the vacuum apparatus. In the detector described, the electrical conductivity of vacuum deposited MoO_3 films is shown to be extremely sensitive to exposure to atomic hydrogen, and relatively insensitive to thermal and ultraviolet radiations. Atomic hydrogen may be detected at an estimated incidence rate of 10^{12} atoms/cm^2/sec, or less, in background pressures of 5×10^{-5} torr. Methods of preparation, operating characteristics, and applications of the detector, are described. (auth)

7742 HEAVY PARTICLE RANGE-ENERGY RELATIONS FOR DIELECTRIC NUCLEAR TRACK DETECTORS. Benton, E. V.; Henke, R. P. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 67: 87-92 (Jan. 1, 1969).

A method for the computation of multicharged particle range-energy and energy loss relations for dielectric nuclear track detectors is described. It is useful in the energy interval 0.1-1200 MeV/nucleon for heavy ions in materials of known atomic composition. The method extends the generalized expressions of Barkas and Berger to lower energies by using the range data of Whaling and the range extensions for emulsion of Heckman, et al., and Henke and Benton. The range calculations have been checked experimentally with the use of lithium drifted solid state detectors from 2 to 10 MeV/nucleon. It is also shown that the corrected length of etched tracks in dielectric track detectors can be used as an accurate measure of the stopping particle's energy. (auth)

7743 SOME NEW SCINTILLATOR-PHOTODIODE DETECTORS FOR HIGH ENERGY CHARGED PARTICLES. Bateman, J. E. (Glasgow Univ.). Nucl. Instrum. Methods, 67: 93-102 (Jan. 1, 1969).

The development of a useful scintillator-photodiode detector suitable for the detection of high-energy charged particles is described. The detector combines the convenient features of solid state devices without suffering from the lack of stopping power associated with pure semiconductor devices. The energy resolution approaches that obtainable with a scintillator-photomultiplier detector under similar conditions. A careful analysis of the physical processes involved in the detection of light by a photodiode is followed by a description of the silicon surface barrier photodiodes. When used in conjunction with CsI(Tl) scintillators the photodiodes made from n-types silicon gave resolution of 15.7% fwhm with 5.48 MeV particles and 4.2% fwhm with 50 MeV protons. Photodiodes made from p-type silicon are described which give similar performance but which are potted in epoxy resin and to which scintillators may be optically coupled in the usual way without any degradation of the diodes' electrical properties. Attention is drawn to the practical advantages of the scintillator-photodiode detector for high energy particle detection and the potential for future development examined. (auth)

7744 SHRINKAGE FACTOR IN NUCLEAR EMULSIONS. Filisetti, O.; Lovera, G.; Minetti Mezzetti, E.; Tedde, P. G. (Politecnico, Turin). Nucl. Instrum. Methods, 67: 74-6(Jan. 1, 1969).

In the determination of the shrinkage factor, with the Vigneron method, using tracks of α-particles coming from a source outside the emulsion, some apparent variations of its value with the depth can result, which can be attributed to a pure gelatin surface layer or to a surface layer with different composition from the remaining emulsion. This interpretation has been checked by experimental measurements. (auth)

7745 FAST LEADING-EDGE DISCRIMINATOR. Conrad, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 67: 148-52(Jan. 1, 1969). (In German).

A fast leading-edge-discriminator is described. It was developed as an alternative to the zero crossing time-discriminator for time measurements using NaI-scintillators in nuclear physical experiments. The threshold is variable continuously between 20 mV to 1 V. Unit-pulses of -2 V at 50 Ω with a rise- and fall-time of about 3 ns and a width of 17 ns are delivered. The electronic time shift is less than 250 ps for pulse amplitudes exceeding 20 times the threshold. At the smallest pulsewidth of 0.8 ns, the threshold increase is 40%. The best time resolution obtained was 0.35 ns measured with γ-γ coincidence of ^{60}Co radiation by 56 AVP and Naton scintillators in fast-slow-technique. When using NaI-scintillators the best resolution was 0.5 ns, hereby the threshold of the discriminator was set just above the noise level of the photomultiplier. (auth)

7746 RAMO'S THEOREM AND THE ENERGY BALANCE EQUATIONS IN EVALUATING THE CURRENT PULSE FROM SEMICONDUCTOR DETECTORS. Martini, M.; Ottaviani, G. (Univ., Bologna. Univ., Modena, Italy). Nucl. Instrum. Methods, 67: 177-8(Jan. 1, 1969).

Some simple experimental evidence is given that the calculation of the current pulse waveform performed according to Ramo's theorem is correct. (auth)

7747 STREAMER CHAMBER USED IN A SEARCH FOR DOUBLE BETA DECAY. Ullman, J. D.; Bardin, R. K.; Gollon, P. J.; Wu, C. S. (Columbia Univ., New York). Nucl. Instrum. Methods, 66: 1-12(Dec. 1, 1968).

A 53 cm dia., 8 cm deep helium-filled streamer chamber is described. At a field strength of 6.2 kV/cm, streamers extend over the entire space between the plates of the chamber and the particle track is shown by bright, narrow regions in the streamers. The mechanism of electrical breakdown in this mode of operation and other modes is investigated. The streamer theory of Raether correctly predicts breakdown-time and dead-space. Penning effect by impurities in the chamber gas appears to influence discharge development significantly at the low field strengths used in track-projecting chambers but not at the high field strengths used in streamer chambers. (auth)

7748 RESOLUTION FUNCTIONS FOR CYLINDRICAL GEOMETRY. Holt, W. H.; Millett, W. E. (Univ. of Manitoba, Winnipeg. Univ. of Texas, Austin). Nucl. Instrum. Methods, 66: 57-60(Dec. 1, 1968).

A simplified method is used to calculate geometric resolution functions for a positron annihilation apparatus utilizing cylindrical geometry. The method is outlined and the results for two different sample configurations are presented. (auth)

7749 GAS DISCHARGE DETECTOR FOR THE DIGITAL REGISTRATION OF THE LOCAL DISTRIBUTION OF IONIZING PARTICLES. Eppie, E.; Decker, D. (Univ., Stuttgart). Nucl. Instrum. Methods, 66: 77-86(Dec. 1, 1968). (In German).

The discussed detector makes it possible to digitize the local coordinates of the passage of ionizing particles. The detection process results from discharges in the proportional and in the limited proportional region between crossed anode wires and cathode strips. The detector allows the discrimination of lower ionizing radiation, i.e., in neutron detection measurements with disturbing background radiation. By wiring the detector with low-ohmic working resistances, counting rates of 10^5 pulses per second are easily reached. The optimum detector geometry and the detector characteristics with regard to the digital registration of the two-dimensional distribution of low-energetic particles are discussed. (auth)

7750 PREPARATION OF THIN LAYERS OF ^{237}Np FOR ABSOLUTE COUNTING AND FISSION DETECTORS. Parker, W.; Colonomos, M. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Nucl. Instrum. Methods, 66: 137-40(Dec. 1, 1968).

A review of electrodeposition procedures for the preparation of ^{237}Np is given and two new procedures reported making use of molecular plating. High voltage–low current yield determinations were carried-out in the region 500–1700 V dc with a deposition current constant at 1.0 mA. The suitability of aluminium, titanium, copper and stainless steel as cathode material was also investigated. It was found that using stainless steel as a cathode and a voltage of 1700 V for a 10 min period resulted in a yield of 100% ^{237}Np, providing that the total solids in solution were within the limits of 20 μg/cm^2 to 500 μg/cm^2. The quality of the layers produced by the described method make them very suitable for alpha-spectrometry and for the fabrication of fission detectors. (auth)

7751 DIRECTIONAL–CORRELATION ATTENUATION FACTORS FOR Ge(Li) γ-RAY DETECTORS. Winn, W. G.; Sarantites, D. G. (Washington Univ., St. Louis). Contracts AT(11-1)-1530; AT(11-1)-1760. Nucl. Instrum. Methods, 66: 61-9(Dec. 1, 1968).

An experimental method for the determination of the angular correlation attenuation factors, due to finite solid angle, for Ge(Li) detectors is offered. The method is tested by comparing the measured factors for a 3″ × 3″ NaI(Tl) detector with available calculated attenuation factors. Results for two coaxial Ge(Li) detectors with active volumes of 20 and 30 cm^3 are presented as a function of distance and energy of the γ-rays. These correction factors were further tested by comparison of the results of measurements of an angular correlation from a ^{207}Bi source, with previously reported results. (auth)

7752 SPARK SCANNING FOR FISSION FRAGMENT TRACKS IN PLASTIC FOILS. Lark, N. L. (Univ. of Copenhagen). Nucl. Instrum. Methods, 67: 137-40(Jan. 1, 1969).

A new technique is described for detecting fission-fragment tracks in thin foils of polycarbonate plastic (Makrofol). First, a sodium hydroxide solution is used to selectively etch away the damaged material along the track, producing microscopic holes through the foil. Then, a spark gap is used as a fast scanning device for detecting the holes and enlarging them to a size visible to the unaided eye. (auth)

7753 LARGE AREA, HIGH CHARGE RESOLUTION, SCINTILLATION COUNTER TELESCOPE FOR COSMIC RAY STUDIES. Von Rosenvinge, T. T.; Webber, W. R. (Univ. of Minnesota, Minneapolis). Nucl. Instrum. Methods, 66: 119-24(Dec. 1, 1968).

A cosmic ray telescope consisting of a 1.7 m long gas Cherenkov detector sandwiched between two large scintillator detectors has been flown from balloons to study high energy heavy nuclei in the primary cosmic radiation. The design and testing of the scintillation detectors are discussed. It is demonstrated that geometry factors two orders of magnitude larger than are in common use can be achieved with no loss of charge resolution. With a geometry factor in excess of 500 cm^2 · sterad we have obtained unambiguous charge determination up to Z = 20. This resolution is comparable to that obtainable with emulsions using photometric techniques. (auth)

7754 EFFICIENCY CALCULATIONS FOR A RECOIL PROTON COUNTER WITH COLLIMATOR. Liskien, H.; Nastri, G.; Paulsen, A. (Central Bureau for Nuclear Measurements, Geel, Belg.). Nucl. Instrum. Methods, 67: 133-6(Jan. 1, 1969).

The efficiency of a recoil proton counter of the Perlow-type was calculated for the case of a parallel neutron beam and the case of a neutron point source. Calculations of open solid angles for a proton collimator–indispensable for the above-mentioned efficiency calculations–were performed without any neglect. The results were compared with an approximation previously used. (auth)

7755 ENHANCEMENT OF TRACK ETCHING RATES IN CHARGED PARTICLE IRRADIATED PLASTICS BY A PHOTO-OXIDATION EFFECT. Crawford, W. T. (General Electric Co., Pleasanton, Calif.). Nature, (London), 220: 1313-14(Dec. 28, 1968).

Among dielectric solids useful for track etching applications are plastic films, notably cellulosics and polyesters, which are very sensitive to a variety of energetic charged particles. Studies are described in which it was found that exposure of a charged-particle-bombarded polycarbonate film to UV energy in an oxidizing atmosphere resulted in a significant acceleration in the etching rate for the damage region along a track, permitting immediate processing and analysis. Polycarbonate film was irradiated in air at 10 to 15 torr to a density of 100 to 3,000 tracks/cm^2 with fission fragments from a ^{252}Cf source, and then subjected to various UV exposure times in air, N_2, O_2, or CO_2. It was demonstrated that oxygen is essential to the chemical fixation of the debris remaining in the vicinity of the tracks. Mechanisms are discussed. The geometry of the "pores" formed on etching was also examined. (UK)

7756 DETECTION OF DISPERSIONS BY THERMOLUMINESCENCE. Gyllander, Christina (Aktiebolaget Atomenergi, Nykoping, Sweden). Tek. Tidskr., 98: 829-30(1968). (In Swedish).

A review is given on thermoluminescent dosimetry. The dosimeter $CaSO_4$:Mn is briefly described. Applications in dispersion studies on airborne and aqueous waste are mentioned. (Swed)

7757 MEASUREMENT OF SMALL ACTIVITY CONCENTRATIONS IN BEAKERS. Grosse-Schulte, Manfred; Leineweber, Hubert; Schruefer, Elmar. Tech. Mitt. AEG-Telefunken, 58: 384-8(1968). (In German).

The calibration measurements of the beaker RS 4 for the measurement of activity concentrations up to 10^{-6} μCi/cm^3 and the beaker RS 85 for the measurement of activity concentrations up to 10^{-7} μCi/cm^3 were described. A lead-shielded measurement chamber was used through which the medium to be studied is pumped and in which the γ activity was measured with a scintillation counter. (J.S.R.)

7758 INTERNAL CONVERSION ELECTRON MEASUREMENT BY A Si SURFACE BARRIER DETECTOR. Tamura, T.; Kuroyanagi, T. (Japan Atomic Energy Research Inst., Ibaraki). Nucl. Instrum. Methods, 67: 38-44(Jan. 1, 1969).

It is shown that combination of a Si surface barrier detector and a paralleled FETs preamplifier under the cooled condition gives a resolution of 2.6-keV fwhm for the K-conversion electron of the 136-keV transition in ^{57}Fe. This method can be applied with many advantages for the measurements of low energy conversion electrons from short-lived activities. (auth)

7759 ADAPTER FOR WELLS OF SCINTILLATION COUNTERS TO PERMIT DIRECT MEASUREMENT OF HIGH LEVELS OF RADIOACTIVITY. Pipher, Edward W.; Grasty, William P. (to Abbott Labs.). U. S. Patent 3,409,776. Nov. 5, 1968. Filed May 3, 1965.

An adapter for wells of scintillation counters which permits the direct measurement of high levels of radioactivity is arranged to hold a source of radioactivity above the well of scintillation counters and has a plug which fits snugly within the opening of the well. The adapter increases the distance of the source from the well and provides shielding to decrease the radioactivity enough to permit measurement in standard well counters and additionally provides a defined geometry so that reproducible measurements can be made. (auth)

7760 CHECK OF ELECTRON BACKSCATTERING COEFFICIENTS AT 10 AND 20 MeV. Harder, D.; Metzger, L. (Univ., Wuerzburg, Ger.). Z. Naturforsch., 23a: 1675-6(Oct. 1968).

Backscattering coefficients for Z = 13, 29, 48, 82 were redetermined with a large area proportional counter containing an insensitive tube passed by the incident beam. Results confirm our previous experience and semiempirical formula. Dressel has recently identified errors in his deviating values. (auth)

7761 IN-LINE ALPHA COUNTERS. Chabert, Jean. (CEA, Marcoule, France). Nucl. Appl., 6: 56-62(Jan. 1969).

In order to minimize the number of analyses per sample, numerous in-line analyzers are used at the Marcoule plant for reprocessing irradiated fuel. These analyzers, which determine plutonium concentration by alpha counting, use a horizontal drum that rotates inside a tank containing the process liquid. The drum transfers a thin, uniform film to a position opposite a ZnS scintillator. The variation coefficient (standard deviation divided by the mean value) is 3.1–3.2% for in-line counters used in the aqueous phase and 4.6% for those used in the solvent phase. (auth)

7762 STOPPING POWER AND LUMINESCENT-RESPONSE CALCULATION FOR CHANNELING IN NaI(Tl) AND CsI(Tl). Luntz, Myron; Bartram, Ralph H. (Univ. of Connecticut, Storrs). Phys. Rev., 175: 468-76(Nov. 10, 1968).

Stopping powers of the most prominent axial channels in NaI(Tl) and CsI(Tl) are calculated for well-channeled ions (^{4}He–^{20}Ne) over the velocity range E/A = 1 – 10 MeV/amu. An electron-gas model is applied to a treatment of the excitation of valence electrons, and an additional term is constructed which accounts for core-electron excitation. Nonparticipating electrons are excluded by application of an adiabaticity criterion. The channel-stopping powers that result are typically 20–25% of those characteristic of random incidence, indicating a relatively pronounced channeling effect for the alkali iodides. The calculated curves are combined with appropriate scintillation-efficiency data (dL/dE versus dE/dx) corresponding to bombardment of NaI(Tl) and CsI(Tl) scintillation counters, in order to obtain a prediction of the luminescent response (L versus E) to the channeled particles, and thus to account quantitatively for a reported anisotropy in the scintillation spectra. Higher than normal scintillation efficiency is predicted for the channeled particles, indicating that the crystal channels in NaI(Tl) and CsI(Tl) are axes preferential for luminescence. This effect may be explained qualitatively by reduced ionization density for channeled particles, which favors radiative recombination of electrons and holes at Tl^+ sites over competing nonradiative recombination. (auth)

7763 RADIATION SENSOR UTILIZING SEMICONDUCTOR BODY HAVING PHOTO-ELECTROMAGNETIC EFFECT. Weiss, Herbert (to Siemens Aktiengesellschaft). U. S. Patent 3,408,499. Oct. 29, 1968. Priority date Dec. 28, 1963, Germany.

A semiconductor crystalline body having a photoelectromagnetic effect is mounted in a magnetic field and has mutually spaced electrodes for providing radiation-responsive voltage between such electrodes. The semiconductor body has between the electrodes a radiation incidence face accessible to radiation to be sensed. The semiconductor body has a multitude of geometrically anisotropic inclusions in the shape of elongated needles which are dispersed and embedded in the semiconductor body and are of higher conductivity than the semiconductor substance of the semiconductor body. The inclusions are oriented transversely to the spacing direction of the electrodes and to the direction of current flow produced by the photo-electromagnetic effect in the semiconductor body. The inclusions are parallel to the direction of incidence of radiation at the radiation incidence face. (U.S. Pat. Gazette)

7764 SIMPLE SCINTILLATION DETECTOR FOR MEASURING LOW-ENERGY IRRADIATION. Makarov, V. P.; Khripach. pp 255-7 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Difficulties in measuring ^{14}C radiation prompted the development of the simple scintillation detector described. An anthracene single crystal in the form of a 20 × 20 × 2 mm plate is used as a scintillator. The single crystal is produced by growing thin organic single crystals according to Korshunov, Kolovskiy, and Solov'yev's method. Following growth of the crystal, its mechanical separation from the holder is a delicate operation. To ensure the safety of the crystal, it is separated by dissolving the holder in water. The operation is conducted in a tumbler (0.25 l) with the holder placed on a net attached to the upper part of the tumbler. Temperature of the water and the holder must be equalized or cracks may form in the crystal. After the crystal is separated, it is attached to a round plexiglass plate (2 mm thick) with Canada balsam. The scintallator sensor is mounted on the cathode of an FEU-35 photomultiplier. The latter is enclosed in a lightproof case which also houses a cathode follower. A high-voltage VS-10 rectifier is used as a power supply. Signals from the cathode follower are transmitted to an amplifier with Sh-2 type discriminator. The scintillation detector is 13% more effective than an end-window counter with a 1.5 mg/cm^2-thick window. (ATD)

7765 NUCLEAR MEDICINE INSTRUMENTS. Davis, R. G. Meas. Instrum. Rev., 15: 877-80(Dec. 1968).

A survey is presented under the following headings: instruments for in vitro measurements (manual, automatic, chromatographic); and instruments for in vivo studies (nonimaging systems including ratemeters and whole body counters, and imaging systems including gamma scintiscanners and gamma cameras). (UK)

7766 METHOD FOR PRODUCING SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS BY DIFFUSING. Schueler, Werner A. (to Oak Ridge Technical Enterprises Corp.). U. S. Patent 3,410,737. Nov. 12, 1968. Filed May 3, 1965.

The method of ion drifting a semiconductor wafer having an n-type region containing diffused ionized donor atoms and a p-type region to drift the ionized donor atoms into the p-type region and thereby form a compensated i-zone between said regions characterized by higher specific resistivity than said regions for use as a nuclear particle detector, comprising the steps of heating said wafer to maintain the wafer at a temperature of between about 90 and 150°C, applying a reverse bias to said wafer to effect drifting of the donor atoms from said n-type region into said p-type region to establish an i-zone therebetween reducing the thickness of said p-type region to a selected minimum thickness, irradiating said wafer during heating and application of reverse bias to said wafer by subjecting the wafer to pulsed radiation energy in frequency bands which produce carriers in the i-zone thereof to produce current pulses of fast rise time denoting creation of carriers in said i-zone responsive to said radiation energy to provide an indication of the thickness of the p-type region. (U.S. Pat. Gazette)

7767 APPLICATION OF SEMICONDUCTOR RADIATION DETECTOR OF CATHETER TYPE TO NUCLEAR MEDICINE. Takayanagi, Seiichi (Tokyo Shibaura Electric Co., Ltd.); Ueda, Hideo. Radioisotopes (Tokyo), 17: No. 7, 64-69(July 1968). (In Japanese).

The radiation detector of semiconductor type has many features, such as the elements are small sized and robust, the incidence

window can be made thin, the modified elements can be made easily, the operating voltage is low, and its life is long. The methods used mostly for the nuclear medicine, have been external measurement of radioactive isotopes administered to living bodies with scintillation detector, or measurements of blood, urine or tissue obtained from living bodies with a well-type detector. It is very convenient to be able to measure directly the local radioactivity by inserting detector into a living body, accordingly the internal medicine department of University of Tokyo and Toshiba Central Research Laboratory together tried and succeeded in manufacturing the semiconductor radiation detector of catheter type, which can be inserted safely into living body, in 1966. The operating principle of radiation detector of semiconductor type, the construction and the characteristics of the catheter type detector were described. The application cases of this detector to the measurement of blood circulation time, the continuous measurement of beating out quantity of the right ventricle of heart, the diagnosis of short circuit of left and right ventricles of heart, and the diagnosis of malignant tumor in the upper gut were shown. (NSA of Japan)

7768 WATER MONITOR FOR α- AND $\beta(\gamma)$-RAYS. Kobe Kogyo Giho, No. 37, 110-12(July 1968). (In Japanese).

The α- and $\beta(\gamma)$-ray water monitor, to monitor radioactive effluents for keeping the radiation level below a permissible value, has been completed in Kobe Industries Corporation. Main features of the monitor are the following: using a special, all-stainless steel pump without a foot valve, the monitor is highly resistant against alkalis and acids; the detection sensitivity is high, and it is strong for abrupt changes of hydraulic pressure such as a water hammer, and by using special scintillators and photomultiplier tubes, the background count is very low, and it also is free from external noises. (NSA of Japan)

7769 EPITHERMAL NEUTRON AND GAMMA RAY DETECTOR. Allen, Linus S, Jr.; Mills, William R, Jr. (to Mobil Oil Corp.). U. S. Patent 3,413,470. Nov. 26, 1968. Filed June 18, 1965.

An epithermal neutron and gamma ray detector comprising a neutron-gamma ray reactive material sandwiched between two gamma ray detectors which are coupled to a common coincidence circuit is described. The neutron-gamma ray reactive material has a resonance peak for reaction with neutrons of epithermal energy. A single shield having a relatively low absorption cross section for gamma rays and epithermal neutrons and a high absorption cross section for thermal neutrons surrounds the neutron-gamma ray reactive material and the two gamma ray detectors. In the preferred embodiment, the neutron-gamma ray reactive material is of indium while the shield is of boron-10 or lithium-6. (auth)

7770 BENZOXAZOLE DERIVATIVES AND THEIR USE AS SCINTILLATORS. (to CIBA Ltd.). British Patent 1,137,033. Dec. 18, 1968. Priority date Jan. 7, 1966, Switzerland.

The use of benzoxazole derivatives as scintillators for liquid scintillation counting is discussed. Methods for preparing the derivatives are outlined and various solvents are suggested. (W.H.K.)

7771 METHOD FOR QUANTITATION OF DOUBLE COLOR AUTORADIOGRAPHY, USING A FILM SCINTILLATION COUNTER. Shigematsu, Akiyo (Anti-Tuberculosis Association, Tokyo); Toyohara, Mareichi; Tokunaga, Noboru; Sueyoshi, Tohru; Motomura, Kazuko; Yoshioka, Shigeyasu. Radioisotopes (Tokyo), 17: 476-82(Oct. 1968). (In Japanese).

A new type of equipment, film scintillation counter, was applied for quantitation of autoradiography. It has been shown that the radioactivity of low energy beta emitters such as tritium and ^{14}C is determined very reliably, easily and rapidly by evacuating the space between the surfaces of sample and scintillator sheet of a scintillation probe, in which the sheet is combined with a prismatic light guide for dividing and transmitting the optical scintillae into two phototubes. Owing to the evacuation, counting of radioactivity has been achieved very efficiently with tritiated samples, even when they are far from the scintillator surface. In this case, 4.5% for tritium and 45% for ^{14}C specimens, respectively, have been found. Examples were obtained from the mice into which both ^{14}C-6-methylcholanthrene and ^{3}H-L-lysine or one of them was administered by peritoneal injection. The mice frozen 1, 6, 24, and 72 hours, respectively, after injection, were sectioned by Leitz 1300 microtome. The thin section, 10 μ, stuck on a glass plate by a piece of binary adhesive plastic tape, Scotch 3M-No. 465, in a -25°C chamber, was transferred and dried in a chilled tank by evacuating in it. Since the temperature in the tank was returned subsequently to the room temperature through gradually heating, the specimens were taken from the tank and on which a thin colloidal carbon membrane was mounted by carbon spattering. Radioactivity of every organ in a mouse-whole body section was counted by the counter and then the section was contacted with double color emulsion to obtain ^{3}H, ^{14}C-double autoradiographic image. The comparison of the counting data and the autoradiographic data showed that both are parallel approximately, even though each data owned to respective property. The counting data showed that the counter could accommodate the wide ranges from 0 to 1,000,000 cpm in each organ, while the autoradiographs could distinguish between the radioactivity value in an organ and 2 or ½ fold-value increase relative to the other organ. Therefore, fine autoradiographic image by just exposure period for the peritoneal portion was obtained on only portion of it, but not the other portions. On the contrary, the autoradiographic images showed successfully the distinction of the label in body fluid and some parts of the intestinal duct. The crowded blue or red image was due to ^{14}C or tritium in body fluid, while the clearly printed blue image of intestinal duct was due to ^{14}C-label in some parts of the intestinal duct. Both counting and autoradiographic data presented that the excretion of ^{14}C-radioactivity from the mouse body was lower than that of ^{3}H-L-lysine. (auth)

7772 A STUDY OF CHARGED-PARTICLE TRACKS IN CELLULOSE NITRATE. Benton, Eugene Vladimir. Stanford, Calif., Stanford Univ., 1968. 245p.

Thesis.

Both experimental and theoretical contributions are presented on the topic of dielectric charged particle track detectors. Cellulose nitrate was the principal track recording material. The study covers four areas: the chemical etch development of tracks; track registration criteria; range–energy calculations and comparisons with the etched track lengths; and charged particle detection. (TSS) (Diss. Abstr.)

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Refer also to abstracts 7795 and 8901.

7773 (CEA-R-3420) A STUDY OF FILTERING PROBLEMS OF BACKGROUND NOISE IN NUCLEAR SPECTROMETRY, IMPROVEMENT OF SIGNAL-TO-NOISE RATIO, AND OF PULSE CHARACTERISTICS PRODUCED BY THE OPTIMUM PREDICTOR DEVICE. Benda, Jerzy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 52p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

The purpose of nuclear spectrometry is the precise measurement of the energy of particles. The resolving power of a spectrometer design is an important factor. Two main phenomena are involved in the limitation of this resolving power: statistical fluctuations of the detector itself, and the background noise. For a given noise, the theory of filters enables the calculation of networks specially designed for the improvement of signal-to-noise ratio. The proposed system should lead to an improvement of 10.5 per cent of this ratio. Experiments have confirmed this theoretical estimation. The predictor device described also makes possible the obtaining of shortened pulses. (auth)

7774 (DP-1171) SYSTEM FOR THE ANALYSIS OF GAMMA-RAY SPECTRA BY THE METHOD OF SIMULTANEOUS EQUATIONS. Knight, F. Delano (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1968. Contract AT(07-2)-1. 21p. Dep. CFSTI.

A complete system for the quantitative separation of complex gamma-ray spectra into their component nuclides was developed and programmed in FORTRAN IV for the IBM 360/65. This system was developed to analyze routine data generated by two multichannel analyzers (three crystal systems) at the Savannah River Laboratory. The system also maintains a current library of standard spectra. The method of simultaneous linear equations is employed. (auth)

7775 (KFK-730) METHODS OF ANALYSIS OF GAMMA SPECTRA. Haase, V. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Apr. 1968. 46p. (In German). Dep.

Numerical methods for the analysis of complex γ spectra, as are obtained with multichannel analyzers and data processing computers, are described. The emphasis of the analysis is on the spectral correction for the effect of the measuring apparatus. The three phases of the correction of measurement data are single-value corrections, corrections to the spectrum or unscrambling, and corrections according to the intensity calculation. (J.S.R.)

7776 (NP-tr-1713) PROCESSING OF DATA FROM A γ SPECTROMETER APPLICATION TO THE STUDY OF DECAY SYSTEMS. Boulanger, J.-P.; Legrand, J. Translated by

W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from report CEA–3285. 29p. Dep. CFSTI.

A numerical method for analysis of data from gamma spectrometers for radioanalysis and the establishment of decay schemes is described. Some results of the method applied to scintillation gamma spectroscopy of the ^{134}Cs system and semiconductor gamma spectroscopy of the $^{95}Zr-^{95}Nb$ system are presented. (W.H.K.)

7777 (TID–24667, pp 35–8) SOME NUMBERS ABOUT THE SPECTROMETERS FOR (e,e') AND e,e'p EXPERIMENTS AT SACLAY. Bellicard, J. B.; Leconte, P.; Mougey, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The beam handling system and the beta spectrometers used for (e,e') and (e,e'p) experiments at Saclay are discussed. (auth)

7778 (UCRL–71210) A COMPUTER METHOD OF PEAK AREA DETERMINATIONS FROM Ge–Li GAMMA SPECTRA. Ralston, H. Robert; Wilcox, George E. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 30, 1968. Contract W-7405-eng-48. 14p. (CONF-681003–8). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

A computer method for determining an appropriate base line (Compton level) from which to begin and end the integration of a peak area and, also, for determining the amplitude of the Compton continuum at the location of the peak is described. (W.H.K.)

7779 ENERGY AND TIME-OF-FLIGHT CORRELATION EXPERIMENTS WITH SOLID-STATE DETECTORS FOR MASS DISTRIBUTION MEASUREMENT OF ^{235}U FISSION FRAGMENTS. Shiraishi, F.; Hosoe, M. (Rikkyo Univ., Yokosuka, Japan). Nucl. Instrum. Methods, 66: 130–6(Dec. 1, 1968).

The post-neutron-emission mass distribution of fragments from the thermal-neutron-induced ^{235}U fission has been measured in the thermal-column of a reactor with a system using two solid-state detectors. In the measuring system the mass of a fragment was calculated by an analog computing circuit from its correlated energy and time-of-flight. Devices which allowed compensation for time walk of the timing circuits and for pulse height defect of the detectors were included in the system and described in detail. Factors which determined the limit of the mass resolution were studied. The measured time resolutions of the system for fragments were 0.43 nsec, fwhm (full-width at half-maximum), for light fragments and 0.62 nsec, fwhm, for heavy fragments. Mass resolutions of 1.5 amu, fwhm, for light fragments and 3.2 amu, fwhm, for heavy fragments were obtained with one-meter flight path. The post-mass distribution obtained by this experiment was found to be consistent with the radiochemical mass distribution, when the number of delayed neutrons emitted from fragments and the mass resolution of the instrument were considered. (auth)

7780 HIGH-EFFICIENT PAIR MAGNETIC SPECTROMETER. Golubnichii, P. I.; Kurdadze, L. M.; Nikolenko, D. M.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Instrum. Methods, 67: 22–8(Jan. 1, 1969).

A magnetic pair spectrometer for γ rays using a spark chamber is described. The spectrometer has been calibrated with a monochromatic beam of 120-MeV γ rays. For a target thickness of 0.014 X_0 the resolution is 1.5%. The possibility of using the spectrometer with a thick target (up to 0.3 X_0) without appreciable loss of resolution was studied. For this purpose the ionization and bremsstrahlung losses of the pair were measured with NaI(Tl) counters. For an effective target, of thickness 0.1 X_0, the resolution is 2.3% and the efficiency 6%. (auth)

7781 INTERMEDIATE-IMAGE SPECTROMETER FOR PRECISION ANALYSIS OF BETA SPECTRA. Nagarajan, T.; Ravindranath, M.; Reddy, K. Venkata (Andhra Univ., Waltair, India). Nucl. Instrum. Methods, 67: 77–86(Jan. 1, 1969).

Eventual distortion of beta spectra due to instrumental components of a spectrometer is discussed. Simple relations for backscattering correction and maximum permissible discriminator bias-setting for any primary energy are suggested. A limit of 0.5% for any changes in the transmission of the intermediate-image spectrometer due to baffle-scattering is prescribed. An exact but easy method of resolution correction due to Hinman without involving any assumptions regarding line-shapes and the true beta spectra is also discussed. (auth)

7782 GAMMA-RAY SPECTROMETRY WITH A SCINTILLATOR–PHOTODIODE COMBINATION. Keil, G. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 66: 168–72 (Dec. 1, 1968).

A scintillator-photodiode combination was used for γ-ray spectrometry. The detector consisted of a silicon guard ring photodiode with a CsI(Tl)-scintillator coupled to its active area. With a small scintillator (2.5 mm dia., 3 mm length) the photopeak of 661 keV γ-radiation from ^{137}Cs was resolved with a fwhm of 18.6%. With ^{60}Co-radiation the 1.33 MeV photopeak could be resolved. The detector combination investigated can be used for γ-spectrometry between ca. 180 keV and 1.5 MeV photon energy at room temperature (25°C). (auth)

7783 INVESTIGATION ON DIFFERENCE-γ-SPECTROMETRY. Altenhein, F. K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 66: 37–44(Dec. 1, 1968). (In German).

The difference-γ-spectrometry was investigated experimentally and theoretically. Difference-γ-spectra were measured using scintillator combinations NaI/anthracene and NaI/plastic NE 102 A. The best results were obtained, when coincidence pulses produced by backscattering between the two scintillators were suppressed. The optimum arrangement of a difference-γ-spectrometer was computed by the Monto Carlo method. Calculations showed that one obtains nearly perfect difference-γ-spectra, if the scintillator combination is surrounded by an anti-Compton-ring made of NaI. (auth)

7784 DETERMINATION OF FAST-NEUTRON SPECTRA IN THERMAL REACTORS BY MEANS OF A HIGH-RESOLUTION SEMICONDUCTOR SPECTROMETER. Silk, M. G. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Nucl. Instrum. Methods, 66: 93–101(Dec. 1, 1968).

The construction of a high-resolution ^6Li spectrometer with a resolution in the region of 90 keV has permitted the extension of fast-neutron spectra measurement in thermal reactors down to an energy of 125 keV. The spectra obtained in the reactors GLEEP and DAPHNE can be combined with earlier data to cover a total energy range from 125 keV to several MeV. This is considerably in excess of nuclear emulsion techniques and comparable with the energy range covered by proportional-counter methods. The spectra obtained are in agreement with the available theoretical spectra and no serious divergence is found in the region of the large resonance in the ^6Li cross section at 250 keV. (auth)

7785 FITTING OF GAUSSIANS TO PEAKS BY A MAXIMUM PROBABILITY METHOD. Ciampi, M.; Daddi, L.; D'Angelo, V. (CAMEN, Pisa, Italy). Nucl. Instrum. Methods, 66: 102–4(Dec. 1, 1968).

The fitting of Gaussians to peaks is possible by a method imposing a maximum probability condition. Experimental and pseudo-experimental peaks have been utilized in order to test this method and in order to compare it with the least-squares one. (auth)

7786 APPLICATION OF FOURIER TRANSFORMS TO THE ANALYSIS OF SPECTRAL DATA. Inouye, T. (Tokyo Shibaura Electric Co. Ltd.); Harper, T.; Rasmussen, N. C. Nucl. Instrum. Methods, 67: 125–32(Jan. 1, 1969).

A computer method for automatically identifying the peaks in complex spectra and determining their centers and areas is described. The principal feature of the method is a data smoothing technique employing Fourier transforms. The smoothing eliminates most of the random fluctuations without affecting the spectral resolution and makes identification of maxima using a zero slope criterion possible. Using the same Fourier transform with different constants it is possible with a second transformation to improve the spectral resolution. The computer program has been written in FORTRAN IV for the MIT IBM 360 model 65 computer and also for the Toshiba Electric Co. GE 635 computer. The complete analysis of a 4096 channel spectrum containing several hundred peaks requires about 75 sec of computation time. (auth)

7787 TIME-OF-FLIGHT SPECTROMETER WITH PULSED NEUTRON SOURCE FROM THE NUCLEAR REACTION $T(d,n)^4He$. Seeliger, D.; Truetzschler, K. (Technische Univ., Dresden). Nucl. Instrum. Methods, 66: 157–66(Dec. 1, 1968). (In German).

The details of a rf chopping and klystron type of bunching system for the generation of short-duration ion bursts in a neutron time-of-flight facility at a 150 kV-cascade accelerator are described. The measurements show that this system can produce very intensive D^+-ion bursts with a duration of less than 2.5 nsec at a T-Zr-target for production of neutron bursts by the T(d,n)-^4He-reaction. In practice this means that a higher neutron intensity may be employed in scattering experiments than by the associated particle method. (auth)

7788 X-RAY SPECTROMETER SAMPLE CELL HAVING AN ADJUSTABLE SECONDARY X-RADIATION RADIATOR AND TAUT X-RAY TRANSPARENT WINDOW. McKinney, Charles N.;

Smith, Harold F.; Pollard, William K. (to Continental Oil Co.). U. S. Patent 3,409,769. Nov. 5, 1968. Filed July 26, 1965.

A sample cell for an x-ray spectrometer is described. The cell has a chamber containing a secondary x-ray radiator adjustably mounted at a plurality of points in the chamber and with a cell window stretched tautly across the chamber so as to provide a constant thickness of sample disposed between the cell window and the secondary x-ray radiator. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 7912, 8708, 8734, and 8759.

7789 (NP-17697) PRELIMINARY STUDY OF THE CHARACTERISTICS OF A STREAMER CHAMBER. Note No. 176. Beneventano, M.; Del Priori, M.; de Notaristefani, F.; Monacelli, P.; Sebastiani, F.; Severi, M.; Vignati, M. (Rome Univ. (Italy). Istituto di Fisica). July 9, 1968. 21p. (In Italian). Dep.

A streamer chamber controlled by a Blumlein type pulse generator, which permits the duration of the high voltage pulse to be varied at will, is described. The apparatus consists essentially of a streamer chamber, a high-voltage pulse former fed by a voltage multiplier operated by two spark chambers in coincidence. Each of these constituents is described. (J.S.R.)

7790 (NP-17699) ANALOG-DIGITAL CONVERTER FOR LABORATORY EXAMINATION. Note No. 175. Di Giacomo, E.; Sebastiani, F. (Rome Univ. (Italy). Istituto di Fisica). July 4, 1968. 18p. (In Italian). Dep.

In the study of the characteristics of a wire spark chamber with magnetostrictive delay lines, it became necessary to construct a simple analog-to-digital converter for laboratory tests. The converter is described. It consists of a sinusoidal oscillator, former gate and converter gate, counting scale and readout device, reset, and overflow circuit. Each component is described. The characteristics and use of the converter are briefly discussed. (J.S.R.)

7791 (NP-tr-1717) POSSIBLE WAY OF MEASURING THE ENERGY OF RELATIVISTIC PARTICLES BY MEANS OF TRANSITION RADIATION. Ispiryan, K. A.; Oganesyan, A. G. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). Translated by D. L. Allan for Atomic Energy Research Establishment, Harwell, Eng., from report No. EFI-ME-4(68). 8p. Dep. CFSTI.

A discussion is given of the angular distribution of the intensity of the transition radiation emitted in the optical frequency range by high energy particles. It is shown that the sharp dependence of the intensity of radiation emitted into a certain angular interval can be used to measure the energy of high energy particles. (auth)

7792 ULTRASONIC HELIUM BUBBLE CHAMBER. Brown, R. C. A.; Hilke, H. J.; Rogers, A. H. (CERN, Geneva). Nature (London), 220: 1177-8(Dec. 21, 1968).

Ultrasonic expansion techniques are being tested in a small helium chamber at CERN. A description is given of the principles of operation, together with some experimental results. (auth)

7793 DETECTION OF INHOMOGENEITY IN SCANNING EFFICIENCIES. Auslaender, J. S. (Univ., Strasbourg. Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Friedlaender, E. M. Nucl. Instrum. Methods, 67: 71-3(Jan. 1, 1969).

A simple, statistical criterion is presented, establishing whether in visual scanning all events are detectable with the same probability, or not. In this way misleading conclusions drawn from the usual method of two-fold scanning can be avoided. (auth)

7794 KINEMATICAL RESOLUTION OF A STREAMER CHAMBER FOR EVENTS WITH UNOBSERVED INTERACTION VERTEX. Derado, I.; Fries, D. C. E. (Stanford Linear Accelerator Center, Calif.). Nucl. Instrum. Methods, 67: 109-15 (Jan. 1, 1969).

Using simulated film data, the resolution of a streamer chamber has been studied in an experimental situation, where the interaction vertex can not be observed, and the magnetic field is nonuniform. In particular the distinction of three-constraint events from zero-constraint events was examined. The analysis of a small sample of real events, observed in a streamer chamber, renders results consistent with those of the simulated events. (auth)

7795 ON-LINE WIRE SPARK CHAMBER SYSTEM USED AS A MASS SPECTROMETER. Graven, R. M.; Neu, F. D.; Steilrecht, H. H.; Torrano, M. A.; Abolins, M. A.; McCarthy, R. L.; Smith, G. A.; Smith, L. H.; Wicklund, A. B. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 66: 125-9(Dec. 1, 1968).

An on-line wire spark chamber system has been built and tested to measure the momentum spectrum of a high-energy secondary beam at the Lawrence Radiation Laboratory's bevatron. The system consists of six dual-plane chambers with one spark per plane, interfaced to a PDP-5 computer. The interface also includes readout for a digital voltmeter, time-to-amplitude converter and scalers used in recording the beam. The computer permits accumulation of statistics for beam tuning and detection and measurement of the desired mass components. The observed spatial resolution of any one chamber is approximately ±0.6 to ±0.8 mm. (auth)

7796 LARGE SOLID ANGLE MOMENTUM-ANALYZING SPARK CHAMBER SYSTEM. Buffington, A.; Frisch, D. H.; Smith, S.; Ward, C. E. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 67: 157-63(Jan. 1, 1969).

This article describes the design and operation of an array of cylindrical spark chambers mounted in a 15.8 kG magnetic field. The array provides momentum analysis of charged prongs and γ-ray detection over approximately 2π steradian. A system of conical mirrors permits photography of the sparks through small holes in the pole-pieces of the magnet. The equipment was operated in an unseparated beam of π^- and K^- particles of momentum 7.7 GeV/c with a neutral-link trigger requirement which permitted observation of neutral V-particles. (auth)

7797 LIVE-TARGET SPARK CHAMBER TRIGGER FOR THE STUDY OF COHERENT INTERACTIONS. Lander, R. L.; Bellini, G.; Holloway, L.; Lubatti, H. J.; Marcus, L. (CERN, Geneva. Faculte des Sciences, Orsay, France). Nucl. Instrum. Methods, 67: 173-6(Jan. 1, 1969).

A lithium-drifted silicon solid state detector was used as a target for scattering 6 GeV/c negative pions. This target was located within a few cm of an optical spark chamber; nevertheless, satisfactory pulse height information was obtained from the detector by gating out the electrical noise, which followed the detector signal by a few hundred nsec. It was demonstrated that a signal from the detector, biased to be greater than that of a single pion traversal in order to insure that an interaction had occurred, could be used to trigger the spark chamber and at the same time yield useful pulse height information. (auth)

7798 HIGH PRECISION 1 GeV/c SPECTROMETER. Bowen, T.; Dawes, W. R. Jr.; Delise, D. A.; Jenkins, E. W.; Jones, J. J.; Kalbach, R. M.; Malamud, E. I.; Petersen, D. V. (Univ. of Arizona, Tucson). Nucl. Instrum. Methods, 67: 141-7(Jan. 1, 1969).

A combination π^- beam transport system and momentum spectrometer was constructed at the Bevatron of the University of California Lawrence Radiation Laboratory. The use of thin Al and Be foil wide gap spark chambers without beam windows, a one radian deflection of the beam, and a beam channel filled with helium to a pressure of 250 Torr allowed for a 0.05% precision measurement of the momenta of individual pions. The maximum usable particle intensity was 10^4 π^-/sec. (auth)

7799 IZLUCHENIE VAVILOVA-CHERENKOVA I EGO PRIMENENIE V FIZIKE VYSOKIKH ENERGII. CHAST II. (Vavilov-Cherenkov Radiation and Its Uses in High-Energy Physics. Part II). Zrelov, V. P. Moscow, Atomizdat, 1968. 304p.

The operating principles of various Cherenkov counters used in intermediate- and high-energy particle physics with accelerators and cosmic rays were described. In particular the Cherenkov device used in working with high-intensity particle beams was discussed. Threshold and differential single-particle counters, Cherenkov gamma spectrometers, total internal reflection counters, Cherenkov counters for determining particle charge, and indicators of charged particle and quanta directions were covered. 202 references. (tr-auth)

Radiation Dosimeters

7800 (AED-C-21-7) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 21. DOSIMETRY. Becker, Klaus (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Sept. 1968. 58p. (In German and English).

Two hundred and fifty-seven references on dosimetry equipment and techniques are presented. Author and subject indexes are included. (B.G.D.)

7801 (CEA-R-3423) PRACTICAL GUIDE TO DOSIMETRY AS APPLIED IN THE RESEARCH REACTORS OF THE SACLAY AND GRENOBLE NUCLEAR RESEARCH CENTERS. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes

Nucleaires. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1968. 63p. (In French). Dep.

Since the problems concerning neutron and gamma flux measurements which arise during irradiation experiments in the reactors in the Grenoble and Saclay Centres are of the same type, and since the solutions found are very often adopted in common, it is attempted to describe the methods used at the present time. A brief description is given of the production of the detectors and the electronic apparatus. The formulae usually used for the interpretation of the measurements are given. A series of technical data cards gives the most commonly used detector characteristics. These cards give the physical characteristics of the detectors, their nuclear constants, if any, the most suitable counting methods, and the field of application. (auth)

7802 (CONF-680920) PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE ON LUMINESCENCE DOSIMETRY, GATLINBURG, TENNESSEE, SEPTEMBER 23–26, 1968. Auxier, J. A.; Becker, K.; Robinson, E. M. (eds.) (Oak Ridge National Lab., Tenn.). 1030p. Dep. CFSTI.

Separate abstracts were prepared for sixty-eight of the seventy-four papers presented. Six papers were previously included in NSA. For abstract numbers of these papers see CONF 680920 in the report number index. (B.G.D.)

For abstracts of individual papers see: 7803–7870.

7803 (CONF-680920–, pp 4-17) CALCIUM SULFATE PHOSPHOR ACTIVATED BY RARE EARTH. Yamashita, T.; Nada, N.; Onishi, H.; Kitamura, S. (Matsushita Electric Industrial Co. Ltd., Osaka (Japan). Central Research Labs.).

$CaSO_4$ crystals activated by rare earth elements were found to be free from the serious disadvantage of rapid fading in $CaSO_4$: Mn and yet retain the outstanding property of high sensitivity of $CaSO_4$: Mn, the most sensitive thermoluminescence dosimeter available at present. Among fourteen kinds of phosphors tested, $CaSO_4$: Dy and $CaSO_4$: Tm showed the highest sensitivity with essentially a single glow peak at about 220°C. Emission spectrum of $CaSO_4$: Tm consists of a main sharp peak at 450 mμ with minor ones at 360, 470 and 520 mμ and $CaSO_4$: Dy has two main peaks at 480 and 570 mμ without any minor one. The dosimetric characteristics of $CaSO_4$: Dy and $CaSO_4$: Tm are excellent except for their non-tissue equivalence. There is little fading (1–2% per month); minimal detectable exposure is lower than 500 μR with standard deviation of ±20%; dose response is linear up to 3×10^3 R, superlinear from 3×10^3 to 10^4 R, and tends to saturation around 10^5 R; tribothermoluminescence is very low (about 30th of that in LiF); they are highly resistant against various spurious effects such as sun beam, artificial light, ambient gases; and constant thermoluminescence efficiency is found for more than 100 times of irradiation after repeated heating to erase previous dose. (auth)

7804 (CONF-680920–, pp 18-26) GLASS THERMOLUMINESCENT DOSIMETER. Spurny, Z. (Ceskoslovenska Akademie ved, Prague. Ustav Jaderneho Vyzkumu).

A thermoluminescent dosimeter (TLD) system in which the phosphor made of aluminophosphate-manganese-activated-glass is described. The main properties were investigated including chemical composition, the effective atomic number Z_{ef} and corresponding energy response, the emission spectra and other optical properties, glow-curve fading, EPR spectra and electrical conductivity. The relative sensitivity in comparison with other TLD phosphors was established. The commercial prototype of dosimeter and reading apparatus is described and their operational characteristics briefly summarized. In conclusion the influence of neutron fluxes and the problem of fading are mentioned. (auth)

7805 (CONF-680920–, pp 27-42) THERMOLUMINESCENCE OF Y_2O_3–Al_2O_3:Tb PHOSPHORS. Sakamoto, Hitoshi; Hitomi, Teiichi; Kotera, Noboru (Dai Nippon Toryo Co. Ltd., Chigasaki. Research Dept.).

New phosphors with compositions of Y_2O_3–Al_2O_3: Tb have been developed, which are utilizable in thermoluminescence dosimetry. Effects on thermoluminescence of composition, Tb concentration and other preparative conditions are investigated. Thermoluminescence properties of resultant phosphors are described, and discussed in regard to the nature of luminescence centers and trapping states included. It is identified that Tb ions cause the main glow peak of nearly 150°C, while residual Eu ions are responsible for the subpeak of 80°C. In $Y_2O_3 \cdot 0.5Al_2O_3$: Tb (2×10^{-4} g·atm.), one of the typical phosphors in this series, dependency of the intensity of thermoluminescence upon exposure keeps a linear relationship over a wide range of more than six orders of magnitude, where the lowest limit of detectable exposure is below 1mR. (auth)

7806 (CONF-680920–, pp 43-53) DOSIMETRIC PROPERTIES OF CaF_2:Dy. Binder, W.; Disterhoft, S.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Radiology).

The general dosimetric properties of CaF_2: Dy (TLD-200) have been investigated. Studies were carried out on 8 different batches. The last five batches showed quite uniform characteristics. The glow curve structure and peak temperatures are given. The TL response was studied up to 10^6 R. The relative heights of the peaks in the glow curve change with the exposure level and radiation quality. The TL-emission spectrum has peaks at 4600Å, 4835Å, and 5765Å. Depending on the readout system TLD-200 was found to be 15 to 30 times more sensitive than TLD-100 on an integrated TL basis. Some annealing characteristics are given and the stability is discussed. TLD-200 shows energy dependence, which was studied from 20 to 1250 keV effective. (auth)

7807 (CONF-680920–, pp 54-9) APPLICATION OF RADIOTHERMOLUMINESCENCE OF SOME PHOSPHORS TO ACCIDENT DOSIMETRY. Huzimura, R. (Nara Univ. of Education (Japan). Dept. of Physics); Ato, Y. (Government Industrial Research Inst., Nagoya (Japan)).

The thermoluminescence(TL) of such phosphors as Y_2O_3: Eu/Sm and 5 $CaF_2 \cdot Y_2O_3$: Eu shows one or two resolved glow peaks at 60 to 130°C. The growth of the TL peak height under irradiation with ^{60}Co γ-rays at low levels, 0.6 and 6 mR/h and fading after an irradiation to 100 R have been studied. By use of the TL peaks of these phosphors, the accident dosimetry is possible at various periods of monitoring and storage times between the accident and the time of measurement. The typical lower limit of dose to obtain a signal 10 times larger than the accumulated background is 1.9 R with Y_2O_3: Eu two hours after the irradiation if the monitoring period before the irradiation was 10 days at a background level of 6 mR/h. (auth)

7808 (CONF-680920–, pp 60-77) NEW, SOLID LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETERS. Cox, F. Morgan (Harshaw Chemical Co., Cleveland, Ohio. Crystal-Solid State Dept.).

Several new types of solid LiF thermoluminescent dosimeters have been developed. These new types are extruded and high sensitivity LiF dosimeters. Both varieties are available in several usable geometries and are the product of controlled high temperature and high pressure. These dosimeters retain the desirable radiation detection properties of LiF powder, e.g., wide exposure measurements range, dose rate independence, essential energy independence, approximate tissue equivalence, long term response retention, etc. In addition, these solid dosimeters have other useful properties, not present in the powder, including optical transparency, reusability, mechanical ruggedness, handling convenience, and others. Range of measuring sensitivity is mainly a function of the mass of the dosimeter. Dosimeter types range in size from 0.25 inch by 0.25 inch by 0.035 inch ribbons for personnel dosimetry applications to 0.5 millimeter diameter by 6 millimeter rods for criticality dosimetry and radiation therapy applications. The dosimeters are described in technical detail. (auth)

7809 (CONF-680920–, pp 78-81) UNIQUE THROWAWAY LiF DOSIMETER. LaRiviere, Philip D. (Radiation Detection Co., Mountain View, Calif.).

A new LiF powder is described, suitable for dosimetry above 1 R. The salient advantages over conventional LiF powder include reduced supralinearity, low cost, and availability in encapsulated form ready for use. (auth)

7810 (CONF-680920–, pp 82-6) CHARACTERISTICS OF RUBY AS A THERMOLUMINESCENT RADIATION DOSIMETER. Buckman, W. G.; Philbrick, C. R.; Underwood, N. (Western Kentucky Univ., Bowling Green).

The thermoluminescence of different ruby crystals is presented. Comparisons are made with the TLD-100 thermoluminescent powder. The ruby from Semi-elements Incorporated with low chromium concentration is shown to have a rather simple glow curve which peaks at 170°C after a simple annealing procedure and to be as sensitive (using 93kvp x-rays, HVL = 2.3mm Al.) as the specially annealed TLD-100. It is suggested that ruby can be utilized as a practical radiation dosimeter, including the near ultraviolet, and that it can be used in tandem with TLD-100 powder to yield information concerning the energy of the x or gamma-radiation exposure. (auth)

7811 (CONF-680920–, pp 90-117) MANGANESE-ACTIVATED LITHIUM BORATE CRYSTALS, GLASSES AND SINTERED PELLETS AS THERMOLUMINESCENCE DOSIMETERS. Christensen, Poul (Danish Atomic Energy Commission, Risoe. Research Establishment).

From the system ($Li_2O \cdot B_2O_3$–B_2O_3), compounds with Li_2O: B_2O_3 ratios of 1:1, 1:2, 1:3, and 1:4, activated by manganese, were

prepared and investigated for thermoluminescence. In addition to the normally reported lithium tetraborate with glow peaks at approximately 60°C and 220–240°C, when a heating rate of 22°C per second was used, a new useful $Li_2O \cdot 3B_2O_3$ phosphor with a glow peak at approximately 190° was prepared. The manganese content in the $Li_2B_4O_7$:Mn phosphor influenced the glow-peak temperature, the glow-peak height, the energy dependence of the dose response, and the resistance to humidity. The response curve for ^{60}Co γ-ray exposures showed supralinearity at approximately 300 R and saturation at about 3×10^6R. When an SbCs photomultiplier was used, the peak-height response of $Li_2B_4O_7$:Mn was about one-third that of LiF (TLD-100). A fading of 37% was measured on storage at 25°C for a period of 13 months. The phosphor was indifferent to previous exposures, and no or a very uncomplicated annealing procedure was required for re-use of the luminophor. Solid dosimeters of lithium borate were prepared either as glasses with thicknesses down to 20 mg/cm^2 or as sintered pellets with thicknesses down to 75 mg/cm^2. Only one broad glow peak was observed for the glasses, with the maximum of the peak varying from 168 to 180°C and the peak-height response varying from ⅓ to ⅔ of that of crystalline $Li_2B_4O_7$:Mn. A high initial fading of 26% on storage at room temperature for a period of eight days made the glass material inconvenient for general use, but as thin dosimeters may be prepared, special low-energy dosimetry measurements are possible. The fading could be reduced to 9% by a post-irradiation annealing of 15 minutes at 100°C. Sintered 185 mg pellets, 12.5 mm in diameter, prepared from the $(Li_2O \cdot 2B_2O_3)$ compound were capable of measuring gamma-ray doses down to a few mrads. The response to thermal neutrons, beta particles and gamma photons with different energies was determined. The applicability of the pellets in a dosimetry system covering dose determination in a mixed radiation field consisting of beta particles, gamma photons and thermal neutrons is discussed. (auth)

7812 (CONF-680920–, pp 118-39) PROPERTIES OF LITHIUM BORATE POWDER AS A SOLID STATE DOSIMETER. Jayachandran, C. A.; West, M.; Shuttleworth, E. (Hammersmith Hospital, London (England). Postgraduate Medical School).

The effect of varying some of the parameters involved in the production of lithium borate is described, with special reference to both the firing time of the molten lithium borate at 950°C, and to its rate of cooling. The most useful dosimetry material was obtained by allowing the melt to cool on the bench after fusing the lithium borate for about 15 minutes. Increasing the concentration of manganese to 0.1% or 0.34% by weight improves both the sensitivity of the phosphor and its response to low energy photons. The emission spectrum for lithium borate peaks at about 6,000 Å, compared with 4,200 Å for lithium fluoride. Borate has about one-eighth of the sensitivity of fluoride using a photomultiplier with an S11 photocathode, but one-half using an S20 photocathode. Shaking of the powder or prolonged storage produces a spurious luminescence (3–5 rads equivalent) which can be suppressed by nitrogen flow. Grinding also induces a spurious luminescence which is unaffected by nitrogen, but which is removed by the standard annealing procedure of 300°C for 15 minutes. The main dosimetry peak has two components. Their relative response varies with dose and with photon energy, producing a supralinearity in dose response which is energy dependent. The supralinearity increases with photon energy. By using suitable proportions of manganese impurity, the energy response of the dosimetry powder can be varied. Lithium borate samples can be made to have a response to low energy x-rays which match that of air, water, or tissue. (auth)

7813 (CONF-680920–, pp 140-7) STUDIES ON THE THERMOLUMINESCENCE OF MANGANESE ACTIVATED LITHIUM BORATE. Wallace, R. H.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind. Dept. of Bionucleonics).

Manganese-activated lithium borate ($Li_2B_4O_7$) powder was studied to determine the effects on thermoluminescence response for variations in percentage manganese impurity, particle-size, pre-irradiation annealing, and post-irradiation storage conditions. All of these parameters were found to affect the light output from lithium borate dosimeters exposed to gamma rays. Fast and thermal neutron sensitivities of lithium borate were determined, and the effects of fast neutron irradiation on the response to gamma rays were studied. (auth)

7814 (CONF-680920–, pp 148-60) LOW-Z RADIOPHOTOLUMINESCENT GLASSES BASED ON LITHIUM BORATE. Becker, K.; Cheka, J. S. (Oak Ridge National Lab., Tenn.).

A radiophotoluminescent silver-activated glass based on the (Li_2O,B_2O_3) system instead of the usual metaphosphate matrix has been investigated. By reduction of the amount of silver activator, glasses with an energy dependence comparable to LiF have been prepared. Maximum radiophotoluminescence (RPL) is developed by a heat treatment. The new dosimeters exhibit good stability even at high temperatures (up to 350°C). The uv absorption spectrum which is induced by high radiation doses is more complex than in phosphate glasses. The absorption at some wavelengths, in particular below 300 nm, is considerably more stable than the most stable absorption band in phosphate glasses at 315 nm. The humidity resistance and sensitivity of lithium borate glasses can be increased by additions of BeO. (auth)

7815 (CONF-680920–, pp 161-75) DOSIMETRIC PROPERTIES OF $Li_2B_4O_7$:Mn (HARSHAW). Wilson, Charles R.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology).

The dosimetric properties of the thermoluminescent phosphor $Li_2B_4O_7$:Mn obtained from the Harshaw Chemical Company have been investigated. Two different batches were studied: Batch No. 3280–42A and an improved phosphor 3202–24A. The response curves and glow curve structure of the batches are given for the range of 10 to 10^6 R. Fading characteristics, emission spectrum, and energy dependence are discussed. (auth)

7816 (CONF-680920–, pp 180-99) DOSIMETRY WITH EXO-ELECTRONS. Kramer, J. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)).

Cold light and cold electrons, luminescence and exoelectron emission are two aspects of the same kind of procedures in solids. As with luminescence one can use exoelectron emission for dosimetry of ionizing radiation. Forms and features of exo-dosimeters, their sensitivity, their measuring range and apparatus for evaluation are described. Up to now, doses between 10^{-6} and 10^{+7} R can be measured; an extension to smaller and higher doses is possible. (auth)

7817 (CONF-680920–, pp 200-19) SOME STUDIES ON RADIATION DOSIMETRY BY THERMALLY STIMULATED EXO-ELECTRON EMISSION (TSEE). Becker, K. (Oak Ridge National Lab., Tenn.).

Results concerning the dosimetric properties of several low-Z (LiF, $Li_2B_4O_7$, BeO) and high-Z ($CaSO_4$, $SrSO_4$, $BaSO_4$, CaF_2) TSEE detectors are summarized. The reading instrument and detector preparation techniques are briefly described. Different factors affecting the shape of the TSEE spectrum, such as the LET of the radiation, and the sensitivity and energy response of the materials are discussed. Dosimeters consisting of mixtures of suitable detectors offer advantages such as the possible reading of interval dose measurements and accumulation of integral doses. Fast neutron dosimetry is possible by the use of recoil proton radiators. It is concluded that TSEE detectors have a number of advantages over other solid-state dosimeters. In particular, they can be made more sensitive, have a sensitive thickness of less than 100 Å, and are simpler to prepare. Fading is only a problem in intense light or if the TSEE occurs below approx 150 to 200°C. (auth)

7818 (CONF-680920–, pp 220-33) ELECTRONEXOEMISSION (EE) AND THERMOLUMINESCENCE (TL) FROM DOPED CALCIUM SULPHATE CRYSTALS. Spurny, Z.; Novotny, J.; Holohlavska, H. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu. Technical Univ. of Prague (Czechoslovakia))

Calcium sulphate has the highest luminescence yield of all known TL detectors. In connection with this fact it is striking that this phosphor also exhibits one of the best EE. This led to a more detailed study of both effects. The TL and EE effects were measured simultaneously in $CaSO_4$-crystals activated with about twenty different elements. Phosphors showing a strong TL effect usually give a well developed EE curve; this can be an evidence for the same responsible centers. On the other hand, some other phosphors do not behave in this way and they have no TL effect, but a well developed EE. Experiments concerning this problem are described. TL activity was detected for about 17 phosphors and the best results were obtained for $CaSO_4$(Mn), $CaSO_4$(Sm) and $CaSO_4$(Mg). The EE effect was registered for 19 phosphors including the best one $CaSO_4$(Pb). (auth)

7819 (CONF-680920–, pp 234-42) RECENT EXPERIMENTS ON X-RAY AND UV DOSIMETRY BY MEANS OF NON-LUMINESCENT CRYSTALS. Henisch, H. K.; Bose, D. N. (Pennsylvania State Univ., University Park. Materials Research Lab.).

A survey will be given of research conducted during the last three years on the dosimetric capabilities of thermally or radiatively stimulated current-glow, and of pyroelectric processes. The materials used are zinc sulfide, diamond and tourmaline. Commercially viable devices have not yet been made along these lines, but the studies made suggest that they may be feasible. In addition, the measurements can be used for the characterization of materials which, by virtue of their low conductivity, do not yield to orthodox methods. (auth)

7820 (CONF-680920–, pp 248-65) PHOTON-RATEMETER SYSTEM FOR LOW-LEVEL THERMOLUMINESCENCE MEASURE-

MENTS. Aitken, M. J.; Alldred, J. C.; Thompson, J. (Oxford Univ. (England). Research Lab. for Archaeology).

In the system described the signal is taken from the photomultiplier anode in the form of pulses corresponding to the arrival of individual photons at the photocathode. After amplification these pulses are fed through a pulse-height discriminator to a rate-meter and the output of this is applied to the Y-axis of a co-ordinate plotter which thus displays the glow-curve in the conventional way. Using a 44-mm diameter bialkali photocathode (in E.M.I. type 9635 Q) a dark count-rate of less than 100 c/s is obtained, without cooling; this is equivalent to a light level that is less than half the level corresponding to the dark current in a conventional DC system. There are also worthwhile reductions in the noise associated with the dark signal and with weak light signals. A subsidiary advantage is that a measurement of this type can be converted into absolute light intensity without a knowledge of the photomultiplier amplification factor and this vastly facilitates comparisons between different systems. Because of the finite discriminator level the observed count-rate is in fact affected by variations in the high voltage supply and in the amplifier gain but to a much smaller degree than in conventional systems. The upper limit of light intensity for which the system response is linear is dictated by "pile-up" effects in the electronics and at present this corresponds to a count-rate of about one Mc/s. For measurements with the photon system to be valid it has to be assumed that the photons being measured are emitted as statistically single events rather than in time-correlated groups. Scrutiny of pulse-height distributions due to radiothermoluminescence and various types of non-radiation-induced thermoluminescence gave no evidence for the latter situation whereas for prompt tribo-luminescence other workers have concluded that photons are emitted in groups of several hundred. (auth)

7821 (CONF-680920–, pp 266-80) COLOR OF SPURIOUS THERMOLUMINESCENCE IN DOSIMETRY PHOSPHORS. Fleming, S. J. (Oxford Univ. (England). Research Lab. for Archaeology).

At low radiation levels of the order of 100 microrads the measurement of the dosimeter peak of phosphors such as LiF and CaF_2 is limited by the magnitude of an additional thermoluminescent peak which is not induced by radiation, and which is termed spurious. The color of this spurious light has been studied and compared to the emission spectrum of the phosphor's dosimeter peak. High accuracy of measurement (to better than 5%) was obtained over the wavelength region of 4000 to 6300Å (despite the considerable variability of the spurious light level from sample to sample of as much as 70%), by use of a twin photomultiplier system. One photomultiplier was used in conjunction with interference filters to measure the spectrum of emission, while the other photomultiplier was used as a monitor of the total amount of spurious light being given out by each sample. The samples were prepared as fine grain deposits on aluminium discs to obtain a uniform flat sample surface, while taking advantage of the much enhanced spurious level produced by use of smaller grains. These results are compared with those published by other workers. Suggestions are made for optimization of the detector system for measurement of the radiation-induced thermoluminescence at low levels. (auth)

7822 (CONF-680920–, pp 281-90) LOW-LEVEL ENVIRONMENTAL RADIATION MEASUREMENTS USING NATURAL CALCIUM FLUORIDE. Aitken, M. J. (Oxford Univ. (England). Research Lab. for Archaeology).

The minimum dose that can be detected with natural calcium fluoride (MBLE) in loose powder form has been reduced to about five microrads by using two new techniques to reduce background levels of thermoluminescence. The spurious thermoluminescence can be quenched by an order of magnitude below the level achieved using oxy-free nitrogen for read-out by the additional precaution of prior washing in domestic water softener. The light-induced thermoluminescence sensitivity can be almost eliminated (as long as exposure is limited to light without ultraviolet components) by heating for a few minutes at 685°C to drain the deep traps responsible for the light-transfer mechanism; this is done in an atmosphere of oxy-free nitrogen in order to avoid damage to the radiation-induced thermoluminescence sensitivity. The minimum dose-rate that can be measured is limited by radioactive impurities in the calcium fluoride itself. The self dose-rate of the standard material is estimated from analysis to be between 8 and 12 millirads per year, and this has been confirmed by measuring the TL acquired in a low background environment in comparison with the TL acquired by a type of calcium fluoride having a lower radioactive content (but inferior TL properties). Field experiments have been made to measure the variation of cosmic-ray dose with depth in the ground; the dose at the surface is higher than the dose at a depth of 4 feet by a factor of 1.75. Application of the technique to measurement of environmental dose-rates on archaeological sites is described and the results are compared with the estimates obtained from measurement of the radioactive content of relevant soil samples. (auth)

7823 (CONF-680920–, pp 302-9) THERMOLUMINESCENCE PROCESSES AND COLOR CENTERS IN LiF:Mg. Claffy, E. W.; Klick, C. C.; Attix, F. H. (Naval Research Lab., Washington, D. C.).

Optical absorption measurements have been made on a large single crystal of commercial LiF:Mg under conditions such that sensitization or non-linear (supralinear) response appear in thermoluminescence. The sensitization process, which consists of a large pre-dose irradiation exposure followed by thermal bleaching at a moderate temperature, introduces a large number of F-centers. The F-center has previously been proposed as the luminescence center; and the sensitization process then consists of introducing a large number of luminescence centers into the material. At doses larger than 10^3R, thermoluminescence response increases faster than the dose. Measurements on crystals, however, show both the Mg (hole-trap) bands and the F-center band increasing linearly in this dose region. A model is proposed that qualitatively explains these phenomena. It proposes that F centers are formed along the track of an energetic electron and that holes are trapped by Mg ions near the track. Recombination is principally between centers in the same track at low doses, but includes F centers from previous tracks at high doses. The model appears to be able to explain sensitization, supralinear response, and previously observed quality (LET) dependences in thermoluminescence. (auth)

7824 (CONF-680920–, pp 317-21) PARAMAGNETIC RESONANCE IN LiF. Bloch, Peter (Pennsylvania Univ., Philadelphia. Dept. of Radiology).

From electron spin resonance measurements it was found that titanium is an impurity in TLD-100 LiF. The concentration of Ti was estimated to be approximately 10 ppM. After exposure of the LiF to 6000 R of ^{60}Co radiation, two satellite lines of the titanium resonance appear in the E.S.R. spectrum. This indicates that the Ti ion is strongly coupled with a trapped electron. Zimmerman and Jones (1967) showed the emission spectra due to photo-excitation of Ti doped LiF was similar to the thermoluminescent spectra. Their result indicated that Ti is associated with a luminescent center in LiF. The strong interaction shown by the E.S.R. measurements between the titanium ion and the trapped electron and the results of Zimmerman and Jones suggest that there is strong interaction between electron trap centers and luminescent centers in LiF. (auth)

7825 (CONF-680920–, pp 322-6) INFLUENCE OF IRRADIATION RATE ON THE PRODUCTION OF F CENTERS IN LiF(TLD GRADE). Ehrlich, Margarete (National Bureau of Standards, Washington, D. C.).

Optically polished samples of extruded plaques of LiF(TLD grade) were given ^{60}Co gamma-ray exposures ranging from about 35,000 to 450,000 R, at exposure rates between about 1.5×10^3 and 5×10^6 R/h. Over this range of exposures and exposure rates, the resulting absorption in the F band was found to be independent of exposure rate, and to increase with exposure, even for exposures for which the thermoluminescence exhibited saturation effects. After thermoluminescence readout at about 235°C, practically all the absorption in the F band created by the ^{60}Co gamma-ray exposures had disappeared. These results are compatible with the dominant role given F centers in some of the current models for the thermoluminescence process in LiF(TLD grade). (auth)

7826 (CONF-680920–, pp 332-40) SUPRALINEARITY OF THERMOLUMINESCENT PHOSPHORS. Cameron, John R.; Suntharalingam, N.; Wilson, Charles R.; Watanabe, S. (Wisconsin Univ., Madison. Dept. of Radiology).

The TL response of many phosphors exhibits a supralinear behavior. A satisfactory explanation of this phenomenon could help our understanding of TL in general. A model of supralinearity is discussed which assumes the presence of a competing trap with a larger cross-section for capture of electrons than the normal dosimetry traps. This model qualitatively explains the experimentally observed properties of LiF (TLD-100). The mathematical formulation gives a reasonable agreement to the experimental TL vs R curves of LiF (TLD-100) and $Li_2B_4O_7$:Mn. (auth)

7827 (CONF-680920–, pp 341-52) SUPRALINEARITY IN LiF. Bloch, Peter (Pennsylvania Univ., Philadelphia. Dept. of Radiology).

LiF dosimeters exhibit a supralinear response for exposures above approximately 10^3R. To explain this supralinearity, Cameron, Zimmerman, and Bland postulated that upon irradiation new

traps were being created. The properties of the radiation-produced traps were taken to be identical with those originally in the material. Suntharalingam postulates, instead, that there is a small density of deep traps, not associated with thermoluminescence, which have a high capture cross section for free electrons. During x-ray exposure the deep traps compete with the traps associated with thermoluminescence for the free electrons. After the deep traps are filled a greater fraction of the excited electrons become available for capture in the traps associated with thermoluminescence. In both descriptions of the supralinear effect, an implicit assumption is made that the spectral output of the thermoluminescent material is the same at low and high absorbed doses. Small spectral changes during thermoluminescence could, however, be important since the quantum efficiency of the photomultiplier cathode strongly depends on the wavelength of light. Thus small changes in the spectral distribution of the thermoluminescence light with absorbed dose would lead to a nonlinear response of the detecting system. To test this possibility, the optical spectrum from the LiF dosimeter was split using a dichroic filter, which transmits wavelengths longer than 450 nm and reflects shorter wavelengths. Two photomultipliers were used to measure the thermoluminescent light: one arranged to record the transmitted light and the other the reflected light. With this detecting system it was found that the luminescent output from LiF tends toward longer wavelengths with increased ^{60}Co exposure. In addition it was found that the detecting system that responded primarily to wavelengths less than 450 nm showed a nearly linear response (1.03 ± 0.05) over the exposure interval from 400 to 6000 R of ^{60}Co radiation. At the same time, over the same exposure interval, the detecting system that responded primarily to wavelengths above 450 nm showed a response that varied as the 1.23 ± 0.01 power of the exposure. These results indicate that the supralinearity is partially associated with spectral changes of the thermoluminescent light from LiF dosimeters. (auth)

7828 (CONF-680920–, pp 353-63) INDUCED LET-DEPENDENCE IN THERMOLUMINESCENT LiF AND ITS APPLICATION AS LET-METER. Carlsson, Carl A.; Carlsson, Gudrun Alm (Lund Univ. (Sweden)).

The sensitivity of thermoluminescent LiF for different radiation qualities has been investigated as a function of radiation history. LiF dosimeters which were pre-irradiated with large doses showed after an appropriate annealing an increased sensitivity for small doses (test doses). This increase was more pronounced the lower the LET of the test dose. A number of radiation qualities, covering a wide LET range, was used for both pre-irradiation and test dose. With each pre-irradiation quality several radiation qualities were used as test doses. A pair of LiF dosimeters, one sensitized and one unsensitized, is proposed and investigated as a LET-meter. The proposed LET-meter shows a promising resolution power for radiation qualities with a dose average LET like that of 30–500 keV photons. With such a LET-meter preliminary measurements have indicated the changes in LET with increasing depth of incident high energy electrons. (auth)

7829 (CONF-680920–, pp 364-88) PREDOSE EFFECTS IN THERMOLUMINESCENCE AND IN LUMINESCENCE DURING IRRADIATION. Aitken, M. J.; Thompson, Joan; Fleming, S. J. (Oxford Univ. (England). Research Lab. for Archaeology).

The acquisition of thermoluminescence by some phosphors is a supralinear function of radiation dose, and often associated with this is the enhancement of thermoluminescence sensitivity by a factor that is dependent on the dose received prior to the last read-out. Various kinetic models are proposed for observations made on quartz. In addition to thermoluminescence measurements, a study has been made with a number of phosphors (including natural CaF_2 [MBLE], LiF [TLD-100], $CaSO_4$ (Mn) and $CaSO_4$ (Sm)) on the extent to which radioluminescence exhibits pre-dose effects, both at room temperature and at elevated temperatures. The luminescence observed is dependent on temperature and usually reaches a maximum a little above the glow peak temperature. In some case (e.g., LiF and CaF_2) the luminescence is enhanced when the material has been predosed; the significance of this with respect to various models is discussed. The measurements reported utilized beta particles from a $^{90}Sr-^{90}Y$ equilibrium source. (auth)

7830 (CONF-680920–, pp 389-95) VARIATION OF ELECTRON-INDUCED RADIOLUMINESCENCE IN LITHIUM FLUORIDE AS A FUNCTION OF TOTAL DOSE. Attix, F. H.; West, E. J.; Pfaff, J. A. (Naval Research Lab., Washington, D. C.).

A measurement has been made of the radioluminescence brightness of LiF (TLD-100) under constant electron-beam excitation, as a function of the total dose accumulated by the phosphor. It is found that between 10^3 and 10^5 rad this radioluminescence increases in brightness gradually by about 50 percent. The corresponding gain in thermoluminescence sensitivity is about tenfold larger. A qualitative explanation in terms of the model of Klick and Claffy is proposed. (auth)

7831 (CONF-680920–, pp 400-9) INTERCOMPARISON OF THE FRICKE CHEMICAL, THE LiF THERMOLUMINESCENT AND AIR IONIZATION DOSIMETERS FOR 6MV, 250 KVCP AND 50 KVP X-RAYS. Karzmark, C. J.; Geisselsoder, Janet (Stanford Univ., Calif. Dept. of Radiology).

An intercomparison has been made between three dosimetry systems using three widely differing x-ray qualities. The radiations used were: 6 MV X-rays produced by a linear accelerator; 250 KVCP X-rays, 3.0 mm Cu HVL; and 50 KVP X-rays, 0.21 mm Al HVL. Air ionization was measured with a plane-parallel extrapolation chamber. The Fricke chemical and LiF thermoluminescent dosimeters were exposed to these beams inside the chamber to ensure identical geometry. A $G_{Fe^{+++}}$ value of 15.6 ions/100 eV was assumed for 6 MV X-rays and the response of LiF is evaluated in terms of rads in water. For the other beams, a $G_{Fe^{+++}}$ value was derived from ionization measurements and LiF response expressed as a function of rads in water as determined by the Fricke dosimeter. For x-rays of 250 KVCP and 50 KVP, the $G_{Fe^{+++}}$ values derived are 14.9 and 14.6 ions/100 eV respectively. An anomalously high response of LiF to 50 KVP radiation was found. For this beam, effective energy 12 keV, and increase in LiF response of almost 100 percent was observed. (auth)

7832 (CONF-680920–, pp 410-23) THE ENERGY RESPONSE OF LiF, CaF_2, AND $Li_2B_4O_7$:Mn FROM 26 keV TO 22 MeV. Almond, P. R.; McCray, K. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.); Espejo, D. (Hospital San Jose, Monterrey (Mexico)); Watanabe, S. (Instituto de Energia Atomica, Sao Paulo (Brazil)).

At the First International Conference on Luminescence Dosimetry in 1965 the decrease in sensitivity of ^7LiF exposed to high energy electrons (6–20 MeV) when compared to ^7LiF exposed to ^{60}Co γ-rays was first reported. In order to investigate further the energy dependence of ^7LiF, and to see if other phosphors exhibit a similar effect, the energy dependence measurements were repeated for ^7LiF and were also performed for CaF_2 and $Li_2B_4O_7$. The measurements were made from an effective x-ray energy of 26 keV to 22 MV x-rays and for 6–18 MeV electrons. The 6–10% decrease in response for ^7LiF was again found and a 3% decrease was found for both CaF_2 and $Li_2B_4O_7$. The difference between ^7LiF and CaF_2 and $Li_2B_4O_7$ can be considered as real since the exposures were undertaken using at each energy, the same calibration. In order to explain the results, the general cavity theory derived by Burlin has been used. Applying this theory, very good agreement with the experimental data is obtained over the entire energy range. This indicates that when interpreting TLD data, the appropriate theory must be considered. (auth)

7833 (CONF-680920–, pp 424-37) THE QUALITY AND LET DEPENDENCE OF THREE THERMOLUMINESCENT DOSIMETERS AND THEIR POTENTIAL USE AS SECONDARY STANDARDS. Tochilin, E.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco, Calif.); Lyman, J. T. (California Univ., Berkeley. Lawrence Radiation Lab.).

The energy dependence of thermoluminescent LiF, $Li_2B_4O_7$: Mn and BeO dosimeters was investigated over a range of x- and γ-ray energies extending from 6 to 2750 keV. Radiation sources included filtered x rays and isotopes emitting γ rays of known energies. In order to correlate the energy deposited in the phosphor with light output the measured response was compared with the computed value of absorbed dose. A systematic increase in light output with decreasing photon energy was observed for all phosphors: this was interpreted as an LET effect. The LET dependence of these phosphors was then investigated with accelerator-produced charged particles for LET values from 0.25 keV/μ to beyond 1000 keV/μ. Response curves are presented which allows the use of LiF and $Li_2B_4O_7$: Mn as secondary standards to measure absorbed dose or exposure. The use of this method for x- and γ-ray measurements down to 6 keV is described. Calibration is by means of a ^{60}Co γ-ray standard. (auth)

7834 (CONF-680920–, pp 438-55) THE RESPONSE OF THERMOLUMINESCENT DOSIMETERS TO PROTONS WITH ENERGIES TO 137 MeV. Parker, C. Varren Jr.; Blake, Kenneth R.; Nelson, John B. (Texas Nuclear Corp., Austin).

Several varieties of thermoluminescent dosimeters of both the LiF and CaF_2: Mn types were exposed to protons with energies from 5 to 137 MeV. The response per unit proton fluence of these dosimeters was measured as a function of proton energy. These measurements were found to agree with calculated response curves based on the energy absorbed in the dosimeter. Measurements were also made to determine the linearity of the response as a function of absorbed surface dose in tissue at 31 and 100 MeV. These results agree with those obtained for ^{60}Co gamma rays.

The effect of dose rate was measured at an energy of 31.3 MeV and the response of the dosimeters was found to be independent of dose rate in the range from 0.33 to 67 rad per sec. (auth)

7835 (CONF-680920–, pp 456-63) RESPONSE OF CALCIUM FLUORIDE AND LITHIUM FLUORIDE TO ALPHA PARTICLES. Lucas, A. C.; Rainbolt, C. (EG and G. Inc., Santa Barbara, Calif.).

The response of hot pressed samples of lithium fluoride and calcium fluoride to americium-241 alpha particles has been measured by allowing the particles to be totally stopped in the sample material. A collimated beam of alpha particles was standardized by measuring the total ionization produced in air. Lower energy alpha particles were produced by placing mylar absorbers between the source and the sample. Spectra were measured using a silicon spectrometer. The response of the TLD materials was found to be less than that measured for gamma rays when the data were reduced to light emitted per unit energy deposited in the phosphor. The relative efficiency of calcium fluoride varied from 0.32 to 0.20 while that of lithium fluoride varied between 0.14 and 0.07. The glow curve shape was variable for lithium fluoride, and the sensitivities inferred depend on the readout method. In general, lithium fluoride has a greater sensitivity to heavy charged particles when the glow curve is integrated than when the dominant peak in the glow curve is used as a measure of absorbed energy. (auth)

7836 (CONF-680920–, pp 464-82) DEVELOPMENT AND APPLICATION OF CALCIUM FLUORIDE FOR EVALUATION OF DOSAGE WITHIN A RADIOACTIVE POWDER MATRIX. Fleming, S. J. (Oxford Univ. (England). Research Lab. for Archaeology).

Calcium fluoride grains intimately mixed in a radioactive powder matrix containing a mixture of alpha and beta radiation will measure the radiation dosage within the matrix, subject to assumptions firstly concerning the relative efficiency of the two forms of radiation in producing thermoluminescence in the phosphor, and secondly concerning the attenuation characteristics of the phosphor for the short-range alpha particles. A calcium fluoride has been prepared with a radiation insensitive outer layer, of thickness corresponding to the maximum effective ranges of the alpha particles studied, by the controlled diffusion of oxygen into the 100 micron grains used. Thus the two components of dosage arising from the alpha and beta radiation may be separated and evaluated by comparison of the thermoluminescence from the completely sensitive grains and similar material which has been oxygenated. The mechanism of the diffusion process, and its effect on thermoluminescence sensitivity, is discussed. A discussion of the possibilities of usage of such a phenomenon is given and comparison is made with other possible methods of alpha-beta discrimination. (auth)

7837 (CONF-680920–, pp 501-17) LET EFFECTS ON THE RADIOPHOTOLUMINESCENCE IN SILVER-ACTIVATED DOSIMETER GLASSES. Becker, K.; Cheka, J. S. (Oak Ridge National Lab., Tenn.).

High LET radiation creates somewhat different radiophotoluminescence (RPL) centers in silver-activated glasses than low LET electrons. The RPL emission spectra of several glasses irradiated with thermal neutrons, in particular of a new lithium borate glass, have been found to be different from the ones in gamma-irradiated glasses. During a stabilizing heat treatment, the shape of the spectrum changes in such glasses. In other commercial and experimental glasses, the differences are less pronounced. In these glasses the build-up and fading kinetics of the RPL may also depend on LET: the gamma-induced RPL is initially more stable than the thermal neutron induced RPL, but the residual RPL after prolonged fading can be higher after thermal neutron irradiation. Glasses which exhibit little LET dependence of their RPL spectra also are less different in the radiation induced absorption spectra than the glasses with a high LET dependence of the RPL. (auth)

7838 (CONF-680920–, pp 518-24) DIFFERENCES OF GAMMA AND NEUTRON INDUCED RADIOPHOTOLUMINESCENCE SPECTRA OF PHOSPHATE GLASS DOSIMETERS. Regulla, D. F. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz).

Fluorometric measurements of ultraviolet excited radiophotoluminescence of usual phosphate glasses yield different shapes of fluorescence spectra after gamma and neutron irradiation. Gamma radiation induces a broad simply built fluorescence band with a maximum at about 600 nm, while after neutron irradiation an additional less pronounced maximum is found at about 460 nm. The results are reported and discussed–also with respect to a possible discrimination of quantum to neutron radiation in dosimetry. (auth)

7839 (CONF-680920–, pp 525-42) SOME STUDIES ON THERMOLUMINESCENCE FROM LITHIUM FLUORIDE AND OTHER MATERIALS EXPOSED TO NEUTRONS AND OTHER RADIATIONS. Ayyangar, K.; Reddy, A. R.; Brownell, G. L. (Massachusetts General Hospital, Boston. Physics Research Lab.).

Studies have been made on the response of lithium fluoride and other commercially available thermoluminescent powders when exposed to neutrons and gamma rays in the medical facility of the MIT reactor. The thermal neutron flux at this facility is about 2×10^{10} n/cm^2-sec. and the gamma ray dose rate is about 25 rad/min. Glow curves obtained with the reactor beam and with ^{60}Co gamma irradiation have been observed for various materials. Lithium fluoride TLD-700 depleted of ^{6}Li is found to be sensitive to thermal neutrons and gives a ^{60}Co equivalent dose of 0.9 rad per 10^{10} nvt fluence. Activation analysis has been used in a negative attempt to determine whether any element other than ^{6}Li contributes to the neutron response. It was concluded that the response is due to a larger amount of ^{6}Li in the TLD-700 than stated. Further, batch to batch variation in response is observed due to the annealing procedure. The ^{6}Li content is estimated by prompt activation analysis using a solid state silicon detector to measure the alpha-triton particles during neutron irradiation. As a first attempt a value of 0.05% ^{6}Li is estimated for the ^{6}Li content of TLD-700 on comparison with the known amount of ^{6}Li in TLD-100. Using the Harvard synchrocyclotron proton irradiations of TLD-700 were made for doses between 100–10,000 rads at 1,2,3 and 4 keV/μ LET positions on the Bragg curve of 120 MeV beam. The doses measured with the TLD method seem to agree very well with those measured with standard methods. However, for intermediate dose regions of 500–1000 rads, the response of TLD-700 is 10–20% higher for protons supporting the observation that high LET radiation has less supralinearity. Glow curves have been recorded for the different powders and different radiation and the variation of peak temperature with heating rate studied. For TLD-600 and TLD-100 powders the ratio of the 255°C peak height to 195°C peak height has been determined for various thermal neutron fluences and it is found that the ratio is approximately 0.4 over a dose range from 0 to 10^4 rads of neutrons. The significance of this observation is discussed in terms of track density and track superposition. It is clearly seen for doses above 500 rads that for protons with 3 and 4 keV/μ LET the peak height ratio is greater compared to ^{60}Co values. This suggests that the measurement of peak height ratio may serve as a rough guide for the estimation of LET of radiations. (auth)

7840 (CONF-680920–, pp 545-51) THE MEASUREMENT OF GAMMA LEVELS WITH ^{7}LiF THERMOLUMINESCENT MATERIAL IN A MIXED GAMMA–NEUTRON FIELD. Beyer, R. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.).

Exposure of commercially available ^{7}LiF thermoluminescent material in a mixed gamma-neutron field results in a response due to both neutron and gamma rays. A simple method has been developed to perform gamma measurements with ^{7}LiF material in a mixed gamma-neutron field. The technique uses two types of thermoluminescent phosphor. One is enriched in ^{7}LiF and the other is enriched in ^{6}LiF. The method is based on the fact that over a wide range of conditions, the relative neutron sensitivities between ^{7}LiF and ^{6}LiF detectors can be treated as a constant. The technique has been developed primarily for gamma measurements where thermal neutron interactions dominate. The technique has been verified experimentally by performing measurements in a critical facility (i.e., a zero power reactor) with two batches of ^{7}LiF that had different neutron sensitivities. (auth)

7841 (CONF-680920–, pp 568-86) THERMAL QUENCHING OF LUMINESCENCE IN SIX THERMOLUMINESCENT DOSIMETRY PHOSPHORS. PART I. QUENCHING OF X-RAY-EXCITED RADIOLUMINESCENCE. Gorbics, S. G.; Nash, A. E.; Attix, F. H. (Naval Research Lab., Washington, D. C.).

The role played by the thermal quenching of luminescence in thermoluminescent (TL) dosimeters has not been investigated previously. If thermal quenching is operative in the temperature region of the glow-peak, changes in heating rate which cause the temperature position of the peak to change would result in non-constant light sums. The direct measure of the TL light sum or the glow-peak height as a function of heating rate is technically difficult. The main problem is that the phosphor temperature tends to lag behind the heating-planchet temperature by an amount which is a function of the heating rate and the degree of thermal coupling. Thus a thermocouple attached to the planchet provides an erroneous measure of the phosphor temperature. Initially (Part I of this report) this problem was side-stepped by studying the thermal quenching of the x-ray-excited radioluminescence under static thermal conditions. Because of the observed similarity of these emission spectra to the corresponding thermoluminescence spectra, the emitting centers involved in both processes are probably the same for each phosphor studied. The resulting curves of brightness versus temperature were found generally to exhibit large discontinuities in the vicinity of the TL glow-peak tempera-

tures, and were therefore difficult to interpret in terms of quenching of thermoluminescence. For this reason, the measurements of Part II of this report were undertaken. (auth)

7842 (CONF-680920–, pp 587-606) THERMAL QUENCHING OF LUMINESCENCE IN SIX THERMOLUMINESCENT DOSIMETRY PHOSPHORS. PART II. QUENCHING OF THERMOLUMINESCENCE. Gorbics, S. G.; Nash, A. E.; Attix, F. H. (Naval Research Lab., Washington, D. C.).

Since the results of the measurement of the x-ray-excited radioluminescence as a function of temperature (Part I of this report) of TL dosimetry materials were difficult to interpret in terms of quenching of thermoluminescence, the direct measurement of the TL light sum and the glow-peak height as a function of heating rate was done. In order to overcome the problem of thermal lag between the heating planchet and the phosphor, a method was developed to achieve a high degree of thermal coupling by mixing powdered phosphor and gold and pressing the mixture to the surface of a gold disk. The glow curves from these gold plaques were recorded with a reader that produced heating programs which were linear to a few percent from rates of 4°C/min up to 640°C/min. By this technique glow-peak heights and light sums were measured for CaF_2:Mn, natural fluorite, LiF(TLD-100), $CaSO_4$:Mn, $Li_2B_4O_7$:Mn, and terbium-activated lithium-aluminosilicate glass over the full range of heating rates. Considerable variability was found in the thermal quenching characteristics of the various phosphors. All but the fluorite and the $Li_2B_4O_7$:Mn showed some decrease in light output at high heating rates. LiF exhibited a decrease for low heating rates as well, with a broad maximum in the light output at about 100°C/min. (auth)

7843 (CONF-680920–, pp 607-12) THERMOLUMINESCENCE SPECTRUM AND THE ENERGY CONVERSION EFFICIENCY OF LITHIUM FLUORIDE. Strash, Alfred M.; Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics).

Thermoluminescence spectra have been measured for lithium-fluoride powder irradiated by protons and also by gamma rays. Thermoluminescence spectra are given for a sample irradiated with 98.1 MeV protons from the cyclotron at McGill University and also for another sample irradiated with cobalt-60 gamma rays at the Naval Research Laboratory. Both spectra appear to exhibit structure in the wavelength region around 5500A. For the proton irradiation, the time-integrated proton flux density was 4.97×10^9 protons/cm^2, which corresponds to an absorbed dose of 512 rads. For the gamma irradiation, the absorbed dose was 500 rads. Prior to irradiation in each case, the samples were given an annealing treatment of one hour at 400°C followed by 24 hours at 80°C. The samples have had no prior irradiation history. Following irradiation the samples were heated to 100°C for 15 minutes. Glow curves of 30 milligram samples of the irradiated material were recorded at the wavelengths indicated on the graph. The thermoluminescence emission is proportional to the differential (in wavelength) efficiency. The differential efficiency is the thermoluminescence energy emitted per unit wavelength interval per unit mass of material per unit absorbed dose. The spectral data points represent thermoluminescence emission integrated over a small (60A) wavelength interval. The energy conversion efficiency of an irradiated sample is the ratio of the thermoluminescence energy emitted to the particulate radiation energy deposited in the sample. For proton irradiation, the energy deposition is easily obtained from the stopping power of lithium-fluoride samples. The absorbed dose from cobalt-60 gamma irradiation is obtained by exposing the sample under electronic equilibrium conditions to a calibrated source. The required exposure time was determined by applying the dose-to-exposure conversion factor appropriate to the irradiated material. The thermoluminescence energy emitted from a sample is obtained by integration over a calibrated spectrum. The monochromator system was calibrated with a quartz-iodine standard source. Corrections are determined for source geometry. (auth)

7844 (CONF-680920–, pp 613-22) COMPUTER ASSISTED THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE THERMOLUMINESCENCE OF LiF:Mg. Grant, R. M. Jr.; Stowe, W. S.; Correll, J. (Denison Univ., Granville, Ohio).

The theoretical application of the Randall–Wilkins model of thermoluminescence (TL) to the irradiation-induced TL glow peaks of LiF:Mg has been studied utilizing computer-assisted analysis techniques. The structure of a single glow peak (its peak position and full-width at half-maximum) is shown to depend on three independent parameters; the heating rate, β, the trap depth, E, and the frequency factor associated with the trap, S. Experimental apparatus utilizing an analog to digital converter and a 512 channel analyzer to collect and store data directly in digital format is described. Successful application of curve fitting techniques to the analysis of the TL of LiF:Mg (70 ppM) is found to yield the following parameters for the 5 glow peaks making up the glow curve: (1) 0.82 eV, 5×10^{11} sec^{-1}, (2) 1.08 eV, 2×10^{13} sec^{-1}, (3) 1.13 eV, 5×10^{12} sec^{-1}, (4) 1.15 eV, 1.2×10^{12} sec^{-1}, (5) 1.36 eV, 2.2×10^{13} sec^{-1}. Peaks one and two decay at room temperature, while three through five show no change after 24 hours. Work in progress and possible future applications for the computer-assisted analysis of data in TL research are summarized. (auth)

7845 (CONF-680920–, pp 623-31) SPECTRAL ANALYSIS OF THERMOLUMINESCENCE GLOW CURVES. Oltman, B. G.; Kastner, J.; Paden, C. (Argonne National Lab., Ill.).

An effort has been made to correlate the spectrum of the light from TL materials, including the far uv, with various kinds of ionizing radiations. An apparatus will be described which has been designed and constructed to provide well-controlled heating ramps and monochromator scanning capability. Results will be given for such analysis for various inorganic TL materials. (auth)

7846 (CONF-680920–, pp 632-6) INITIAL FADING CHARACTERISTICS OF LiF–TEFLON MICRORODS. Orton, C. G.; Busemann, E. (New York Univ., N. Y. Medical Center).

Significant fading occurs with Conrad Type 7 LiF microrods during the first few hours of storage at room temperature after irradiation. Graphical analysis shows that this fading can be represented as the exponential decay of 3 separate components with half-lives of 1.0 min., 4.2 min., and 34 min. Experiments at 0°C show that this instability does not, however, appear to obey simple 1st order trap decay kinetics. The elimination of early fading by post-irradiation annealing for 15 mins. at 60°C is possible though inconvenient. Pre-irradiation annealing for 24 hours at 80°C does not eliminate the instability. One of the merits of LiF dosimetry is the long term stability of the induced TL signal. However, Anderson, Feldman and Williams reported that even with pre-annealed LiF powder, the response is unstable during the first few hours after irradiation. For accuracy TL measurements should be delayed until this period of instability has passed. Nevertheless, when such a delay is impracticable, methods for the elimination or quantitative estimation of the fading must be employed. The results of a study of early fading in LiF-Teflon microrods are reported. (auth)

7847 (CONF-680920–, pp 640-51) VERSATILE AUTOMATIC SAMPLE CHANGER FOR READING OF THERMOLUMINESCENCE DOSIMETERS AND PHOSPHORS. Boetter-Jensen, Lars (Danish Atomic Energy Commission, Risoe. Research Establishment).

The TL-reader to be described is a modified model of the reader described in an earlier report prepared for the Symposium on Nuclear Electronics and Radioprotection, March 4–8, 1968, Toulouse, France. The electronic part has been completely changed, and a peak-reading facility has been constructed for registration of the glow-peak amplitudes. The instrument has a capacity of twelve samples and is provided with a compensating system for the black-body radiation. A description is given of the performance of the instrument and of measurements carried out to demonstrate the compensating effect in which the black-body radiation was reduced with an optical filter. (auth)

7848 (CONF-680920–, pp 670-6) ELECTRO-OPTICAL TECHNIQUES FOR ULTRASENSITIVE RADIOPHOTOLUMINESCENT DOSIMETRY. Kastner, J.; Langs, R. K.; Cameron, B. A.; Paesler, M.; Anderson, G. (Argonne National Lab., Ill.).

The factor which has limited the sensitivity of photoluminescent dosimetry has been the pre-dose or matrix fluorescence background which is stimulated during readout by the usual continuous ultraviolet exposure. The signal to noise ratio has only been partially optimized by selective choice of filters and optical geometry. A microdosimetric system was conceived and investigated which is potentially capable of sensing extremely low radiation dosages (in the order of microrads). This system depends on the little-known fact that the decay time for the visible luminescence, which is a measure of the absorbed dose, is at least ten times longer than the decay of the indistinguishable visible fluorescence (to uv) which is an inherent characteristic of unexposed silver phosphate glasses. The principle was confirmed some time ago using an ultra-violet laser and was reported elsewhere. In the hope of simplifying the reader, experiments have been carried out using an electro-optical Pockels shutter and much cheaper and less complex uv sources. To date we have been successful in obtaining a 2 to 1 signal to noise ratio from a Toshiba fluorod exposed to 10 mR. (auth)

7849 (CONF-680920–, pp 677-88) PREDOSE AND SENSITIVITY OF RADIOPHOTOLUMINESCENT GLASSES. FLUCTUATIONS IN MEASUREMENT: A NEW METHOD OF CALIBRATION. Chapuis, Anne-Marie; Francois, Henri; Pichoret-Chartier, Monique (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires).

Dose measurement with radiophotoluminescent glasses is not a problem for measurement of relatively high doses. This is no longer true when the predose in the glass is no longer negligible

compared with the measured dose, especially when undertaking experiments of long duration. The difficulties which we have encountered are due to the method of adjusting the apparatus and are limited by the geometric factor. Successive irradiations were carried out on the same dosimeter and the low doses delivered during periods of the order of several months were measured. In the two cases it should be possible to subtract the readings at different times which might be quite well separated. This requires that all measurements are made on the same apparatus and with adjustments and geometry that are exactly the same. The following problems are examined to modify and improve the sample carrier and the reading system, not to interfere with either routine measurements or long term experiments, to measure the dosimeters on any one of our readers interchangeably, and to compare measurements made in different laboratories. To resolve these problems a new method of calibration was set up which defines the characteristics of the reader for each series of measurements carried out with the particular reader. (auth)

7850 (CONF-680920–, pp 689-704) APPARATUS FOR THERMOLUMINESCENCE MEASUREMENTS. Land, P. L.; Wysong, E. D. (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

A versatile variable temperature rotatable optical cryostat is described. The cryostat housing and associated equipment are mounted on an optical bench for convenient alignment. Either a liquid nitrogen or a liquid helium dewar can be used with the housing which has convenient features such as a teflon bearing on which the supporting surfaces of the dewars turn, and threaded window ports for ease in coupling to the various associated apparatus. Some details such as hand winding and potting of heaters in sample holders and choice of adhesives for sample mounting are included in the discussion. A simple and inexpensive means of achieving an approximately linear heating rate for thermoluminescence measurements is described, where the control function is provided by a resistance network containing thermisters. A low resolution, rapid scan spectrometer, which consists of interference filters set in a rotating wheel and enclosure, is described. Use of this spectrometer permits dramatic resolution and characterization of glow peaks which result from traps having nearly the same activation energy, whenever the recombination processes are different, as well as providing the emission spectrum at any temperature during the glow. When prominent line emission is detected, further resolution is achieved with a grating spectrometer. The filter wheel is also convenient for polarization studies. (auth)

7851 (CONF-680920–, pp 705-19) THE HARSHAW MODEL 2000 THERMOLUMINESCENCE ANALYZER. Richey, J. B.; Carlson, R. W. (Harshaw Chemical Co., Cleveland, Ohio. Crystal-Solid State Dep.).

A thermoluminescence analyzer has been developed for use in analytical and personnel dosimetry and nuclear medicine. It incorporates the flexibility required for analytical studies of the thermoluminescence phenomenon as well as the stability and ease of operation required for large scale personnel dosimetry. The basic range of the instrument using solid or powdered lithium fluoride is several mR to 10^5 R. Using more sensitive CaF_2, fractions of an mR have been measured. The analyzer is comprised of two components: A Thermoluminescence Detector and an Automatic Integrating Picoammeter. The system has several unique features, including a thermoelectrically cooled temperature-stabilized photomultiplier tube and thermocouple feedback control of heater temperature to provide linear heating rates for glow curve analysis. The system is described in technical detail. (auth)

7852 (CONF-680920–, pp 722-36) APPLIED THERMOLUMINESCENCE DOSIMETRY PROGRAM AT THE NRTS. Cusimano, John P.; Cipperley, Foster V.; Culley, John C. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

The AEC, ID Health Services Laboratory at the National Reactor Testing Station is the first organization in the United States to develop and apply thermoluminescence dosimetry for personnel monitoring on a large scale. For the last two years more than 3,000 low-exposure-probability personnel have been monitored with TLD's as a replacement for film on a 3 or 6 months servicing schedule. The objectives of the program are reviewed along with the problems encountered in handling, readout and large-batch annealing. Laboratory and field tests indicated the extreme accuracy and reliability of certain thermoluminescent dosimeters for low-background environmental surveillance. It is now possible to measure gamma exposures in the few mR range on a routine basis using CaF_2: Dy extrusions. Data are presented from the environmental surveillance program on the 894 square-mile NRTS complex and the surrounding communities. TLD applications to the NRTS-wide health physics program such as finger and hand dosimetry, shielding measurements, radiation source calibration and use of TL dosimetry as applied to doctors and nurses handling radiation accident victims are also discussed. Methods and procedures devised for use at the Laboratory decontamination facility and shielded operating room are presented. Other applications of TLD such as in core gamma heating measurements and the determination of the magnitude of the buildup of integrated dose from the shutdown field after scram demonstrates the great potential and utility of TLD over existing methods and techniques of reactor measurements. (auth)

7853 (CONF-680920, pp 773-82) β DOSIMETRY WITH SILVER-ACTIVATED PHOSPHATE GLASS. Yokota, R.; Muto, Y. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Prefecture (Japan). Central Research Lab.); Miyake, T. (Nippon Atomic Industry Group, Kawasaki, Prefecture. Research Lab.).

For glass dosimeters, β-sensitivity in the energy region about 2 MeV has been reported to be low. This is proved not to be an inherent property. If glass of trapezoid shape and a special cell for holding it are used, 10 m rads of ^{204}Tl β-rays can be measured using the FGD-6 Type Fluorimeter. The response vs average β-ray energy has been obtained. From the two readings taken by the movement of the cell's slit, skin dose can be measured with this single glass in its badge case with two different window materials. Smaller trapezoid glass and its badge case are developed. This badge case is so small that if attached to the inner side of the forefinger can be conveniently used. These two types of trapezoid glass encased in their badge cases with 12 mg/cm^2 window material have the energy independent response within ±20% from 0.02 to 1 MeV (average energy) for the β-rays which is attenuated by 7 mg/cm^2 protective layer. (auth)

7854 (CONF-680920–, pp 751-72) THERMOLUMINESCENCE DOSIMETRY SYSTEM BASED ON EXTRUDED LITHIUM FLUORIDE DOSIMETERS. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

Measurements made on different forms (powder, silicone encapsulated, single crystal and extruded) of lithium fluoride, are reported. These show that the extruded form is the most suitable for general purpose γ-dosimetry. It is easy to use and reproducible. Standard deviations, in batches of 10, were measured at 10 mR, 100 mR and 100 R levels. They were 10, 2.7 and 1.4 per cent respectively. A holder incorporating a perforated tin filter has been designed. This protects the lithium fluoride against contamination, provides electron equilibrium for high energy γ-rays and compensates for the low energy enhancement of sensitivity. Energy and angular dependence data of the LiF in its holder are presented. A reader has been designed, using a Harshaw heater, that includes an analog-to-digital converter giving one output pulse per mR. These pulses are stored and displayed in a scaler and, at the same time the pulse train is applied to a count rate circuit for a glow-curve output. The analog-to-digital converter is gated so that only pulses from the high temperature peak are stored in the scaler, thus avoiding the need for post irradiation annealing. An adjustable count down circuit is used to subtract the count associated with an unexposed dosimeter. Exposures of 1 mR to 1000 R can be read without range changing. Standardization of the instrument is carried out with dosimeters, both exposed to a known dose and unexposed. This procedure, unlike one depending upon a light source, calibrates and checks the whole system including the dosimeters and their treatment. The reader is designed as a step towards automation. It is intended to transfer the scaler count together with an identification code to an external memory or record. The advantages and problems of automation and some solutions are discussed. (auth)

7855 (CONF-680920–, pp 783-806) PHOSPHATE GLASS DOSIMETERS FOR THE MEASUREMENT OF ORGAN DOSES WITH REDUCED BODY INFLUENCE. Piesch, Ernst (Kernforschungszentrum, Karlsruhe (West Germany)).

According to the ICRP recommendations, the hazard to a person depends primarily on the corresponding absorbed dose in the organ of interest. A personnel dosimeter calibrated for exposure will normally indicate the dose on the surface of the body. The dose actually absorbed in an organ was measured by A. R. Jones in an Alderson phantom related to an exposure of 1 R as a function of quantum energy. Basing on this work, energy compensation filters for phosphate glasses were developed. The dose reading of such dosimeters shows the same energy dependence as the absorbed dose in the critical organ, as gonads, bone marrow, gastrointestinal tract, lenses of the eyes. Different possibilities of oxygen dose indication at the front side of an Alderson phantom were realized: the dosimeter reading is energy independent, at least, for radiation incidence on the front side of the phantom, and the dosimeter reading is energy independent for radiation incidence from the front and likewise from behind the phantom. Phosphate glass dosimeters will be described indicating directly the absorbed dose in all interesting critical organs with reduced influence of body orientation to radiation incidence for quantum energies above 50 keV. The indication of the absorbed dose in the organ testes and gut mucosa is roughly

independent of the direction of radiation incidence from the front or rear half space. For the other organs or for lower quantum energies, detailed statements about radiation quality and radiation incidence are required. Here, the depth dose distribution in phosphate glasses, which can be measured by employing a multiscanning technique, offers the additional advantage of indicating the dose actually absorbed in the body. (auth)

7856 (CONF-680920–, pp 807-13) THERMOLUMINESCENCE PERSONNEL DOSIMETER BADGE. Jones, Douglas; Webb, Geoffrey (Isotopes, Inc., Westwood, N. J.).

A personnel dosimeter badge is described in which the design is based upon the concept that since the I.C.R.P. defines the maximum permissible exposures to specific body sites, e.g., skin, gonads and bone marrow, then the ideal dosimeter is one that will give directly the dose to these critical sites. The relationship between the exposure at the chest wall, which is the normal position for a badge dosimeter and the dose delivered to the critical sites for various photon energies has been measured by A. R. Jones. The approach has been to take a material which is approximately tissue-equivalent (LiF-Teflon) and modify the response by means of appropriate filters to simulate these critical sites. The front cover of the badge contains identification information including a number which can be coded on the side of the badge in a series of notches for automatic readout. The form of the information retrieved from this badge and the routine procedure for its use within a complete thermoluminescence dosimetry system will be described. (auth)

7857 (CONF-680920–, pp 814-29) COMPARISON OF THERMOLUMINESCENT AND FILM DOSIMETRY IN ROUTINE RADIATION DOSIMETRY. Eastes, J. D. (General Dynamics/Fort Worth, Tex.).

Routine radiation monitoring data derived from LiF thermoluminescent and DuPont 555 film dosimetry at the Fort Worth Division of General Dynamics are analyzed and compared on the basis of the following readout procedures: individual weekly readout of both, accumulated totals of the weekly readout of both for a semi-annual period, and an annual readout of the TL dosimeters at the end of the year versus the accumulated film results for the year. Factors which influenced these comparisons are discussed. The response of ^{7}LiF dosimeters exposed repeatedly to gamma radiation ranging from 0.015 to 10.0 R delivered and read out on a weekly basis showed no variation in sensitivity throughout a 90-week period even though some of the dosimeters had received accumulated exposures in excess of 900 R during this period and were never annealed except as accomplished during the normal readout procedure. The natural radiation background, including possible influences from cosmic ray and internally contained sources such as ^{14}C, ^{40}K, ^{226}Ra, etc., was determined to be 60 ± 4 mR/year from the response of thermoluminescent dosimeters contained in badges assigned to 74 unexposed firemen. Modified readout techniques which permit the use of a storage or memory peak in the ^{7}LiF glow curve (285°C peak) for routine monitoring applications are presented along with investigative results. The same techniques have been used to produce duplicate readings from exposed dosimeters, and to extend the useful range of this material to exposures in excess of 10^{6} R and possibly to greater than 10^{9}R. A brief review of the non-routine applications (neutron radiography, flash X-ray exposures in a reactor environment, etc.) of the TL system is given. Operational experience with the system (commercially available) is discussed briefly. (auth)

7858 (CONF-680920–, pp 830-52) ROUTINE DOSIMETRY WITH PHOSPHATE GLASSES. Piesch, Ernst (Kernforschungszentrum, Karlsruhe (West Germany)).

At the Karlsruhe Nuclear Research Center phosphate glasses were used as routine personnel dosimeters for all persons but also as long-time accumulating dosimeters outside the installation and reactors in the vicinity of the center. The Karlsruhe spherical dosimeter consists of a perforated tin-plastic-boron casing and a Yokota type glass with a lower γ-exposure limit of about 40 mR for one year of dose accumulation. The dosimeter reading is energy and direction independent for quantum energy above 45 keV and shows the dose-equivalent of thermal neutrons. Moreover, the dosimeter serves as a criticality dosimeter. In case of an accident, the neutron induced β-radioactivity of the glass – resulting from thermal neutrons by the reaction P-31 (n,γ)P-32 and from fast neutrons by the reaction P-31(n,p)Si-31 – will be measured in the first 15 hours after the accident. The lower detection limit for the dose indication of fission neutrons is 0.5 rad. As a result of past years routine dosimetry, examples of health physics applications such as comparison studies with other personnel dosimeters in different installations, the measuring accuracy for calibration exposure and for routine monitoring, and measurement of the accumulated annual dose from background radiation inside and outside of the installations will be given. A résumé will be given on recent developments of phosphate glass dosimeters in the Karlruhe Nuclear Research Center. A new method of fluorescence measurement (multiscanning technique) offers the possibility to measure the depth dose distribution in the glass and the radiation quality for quantum radiation below 100 keV. (auth)

7859 (CONF-680920–, pp 858-67) DATING OF ANCIENT POTTERY BY THERMOLUMINESCENCE. Zimmerman, D. W. (Oxford Univ. (England). Research Lab. for Archaeology).

Routine dating of pottery has been obtained by a thermoluminescence technique that is both convenient and accurate. Absolute ages are now obtained by taking into account the following two factors: the effectiveness of alpha particles in inducing thermoluminescence, which varies, for different pottery, from 5 to 30 percent of the beta or gamma effectiveness; and the inhomogeneity in thermoluminescent sensitivity and radioactivity of the constituents of the pottery. The thermoluminescence comes predominantly (if not entirely) from mineral inclusions (e.g., quartz) whereas most of the uranium and thorium is in the clay matrix. Because of the short range of the alpha particles, the alpha dose received by the mineral inclusions in antiquity will vary with their size. These difficulties have been met by measuring the thermoluminescence from only fine grains, about one to five microns in size separated from the pottery. These fine grains will have suffered very little attenuation of alpha dose. The thermoluminescence is measured with samples thin enough that they can be given an alpha as well as a beta irradiation to determine their sensitivities. The alpha and beta dose received in antiquity is from uranium, thorium, and potassium in the pottery and this dose rate is determined by alpha counting and flame photometry. The gamma dose is determined by similar measurements on a sample of the soil that surrounded the pot in antiquity. A test program of fifty pottery fragments of known age, from 600 to 3500 B.P., has given the correct age for most archaeologic contexts to within ±10 percent. (auth)

7860 (CONF-680920–, pp 868-82) DOSIMETRY PROBLEMS RELATED TO THE THERMOLUMINESCENCE DATING OF ANCIENT CERAMICS. Mejdahl, Vagn (Danish Atomic Energy Commission, Risoe. Research Establishment).

The dating program described comprised a series of Danish sherds of known archaeological age covering the period 4000 B.C. – 500 A.D. The procedure was based on the separation of large mineral inclusions for measurement of the natural TL. Dosimetry problems related to the determination of accumulated exposure, intensity of radiation from sources inherent in the sherds, and intensity of natural background radiation at the excavation sites are discussed. The TL dates obtained are compared with the stated archaeological dates. (auth)

7861 (CONF-680920–, pp 883-93) LUMINESCENCE DOSIMETRY WITH TIME LAPSE INDICATION. Sidran, M. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.).

The general principles of a novel radiation dosimeter which indicates, in addition to the dose, the time elapsed since exposures are described. Conventional dosimeters yield only the dose. The procedure for its use was demonstrated with an infrared-stimulable phosphor serving as the dosimeter. The use of thermoluminescence and electroluminescence for time-lapse indicating dosimetry is also discussed. The period during which time readout is possible can be adjusted through proper fabrication of the dosimeter. This technique has applications to space experiments and to personnel protection. (auth)

7862 (CONF-680920, pp 894-909) RADIOTHERMOLUMINESCENT ALUMINUM OXIDE AS BUILDING MATERIAL FOR ACCIDENTAL γ RADIATION DOSIMETRY. Portal, Guy; Francois, Henri (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires); Carpentier, Serge; Dajlevic, Radovan (Societe Carbonisation Entreprise et Ceramique, Montrouge (France)).

Roof tiles containing quartz and feldspars, were used to estimate the γ radiation doses from the atomic bomb explosions in Hiroshima and Nagasaki. Such a method could be used in other circumstances, for instance in the case of criticality accidents. To avoid the difficulties encountered by the Japanese authors, the use of bricks or tiles containing a large amount of a dosimetric radiothermoluminescent material in buildings is described. As a result of the studies, a quality of industrial aluminum oxide available in large quantity, at a low price, was chosen. The crystallographic and chemical characteristics of this material, in connection with its radiothermoluminescent properties, were analyzed. A thermoluminescent glow curve with four energy levels was presented. The half life value of each energy level at room temperature was given. The deepest ones can be measured either separately or simultaneously; the method used was described. The sensitivity

of this phosphor is fairly good; an ordinary reader can measure from 500 mrad to 80,000 Rad. For low doses, it is necessary to remove triboluminescence with nitrogen during the reading; different values of triboluminescence depending upon the treatment of the phosphor are reported. The energy response for x and γ rays and the sensitivity to light and to neutrons of these crystals are reported. The physical characteristics and ease of decontamination of different models of roof tiles, wall tiles, and bricks to be included in nuclear or public buildings are described. A practical method for easy collection and reading of samples is included. (auth)

7863 (CONF-680920–, pp 910-16) APPLICATION OF THERMOLUMINESCENCE OF NATURAL QUARTZ TO ACCIDENT DOSIMETRY. Ichikawa, Y. (Nara Univ. of Education (Japan)); Higashimura, T. (Kyoto Univ. (Japan). Research Reactor Inst.).

Results of a study to estimate the gamma rays from the atomic bombs dropped on Hiroshima and Nagasaki by employing quartz contained within roof tiles are discussed. The study of thermoluminescence dating of pottery using separated mineral fractions is now in progress. Since natural quartz can easily be found everywhere, it can be used for dosimetry of radiation accidents at unexpected places. The present investigation examined thermoluminescence properties of natural quartz, such as a single crystal of Brazilian quartz, the grains of quartz contained within tuff and quartz sands, from a viewpoint of measurement of accident dosage. (auth)

7864 (CONF-680920–, pp 920-35) LiF THERMOLUMINESCENCE DOSIMETRY IN TRABECULAR BONE. Zanelli, G. D.; Spiers, F. W. (Leeds Univ. (England)).

The problems of dosimetry in trabecular bone will be discussed with reference to the intricate structure of the bone. Results of experiments on human, dog and pig vertebrae using finely ground LiF, will then be given. The results will be compared with standard and new methods of calculation. It will be shown that calculations based on Spiers' linear path method agree well with the experimental findings. Some phenomena relating to very fine LiF which came to light during the course of the experiments, will be discussed. (auth)

7865 (CONF-680920–, pp 936-43) HIGH PRECISION DOSIMETRY USING THERMOLUMINESCENT LiF. Carlsson, Carl A.; Martensson, Bengt K. A.; Carlsson, Gudrun Alm (Lund Univ. (Sweden)).

Precision in dosimetry with thermoluminescent LiF is adversely affected by the effects of individual differences of dosimeters, thermal history, radiation history, and fading. The effects of pre-annealing at various temperatures have been studied and the precision in repeated dose measurements has been determined by variance analysis. For a pre-annealing time of 22 hr, following a short-time 300°C-annealing, the standard deviation shows a minimum at a pre-annealing temperature of about −30°C. This standard deviation increases with increasing pre-annealing temperature and is 4 times higher at 300°C than at −30°C. As this standard deviation increases with increasing pre-annealing time, it is recommended that the necessary pre-annealing at a high temperature be no longer than needed to ensure the emptying of all filled traps and to produce thermal equilibrium of those crystal states that have changed after the previous high-temperature pre-annealing. For measurement with high precision ($\sigma \approx 0.3\%$) the dosimeters must be individually calibrated. A simple device which facilitates giving a constant absorbed dose to an arbitrary number of LiF-teflon dosimeters is described. When measuring depth-dose distributions which vary appreciably over the dosimeter, the change of sensitivity with depth in the dosimeters has been determined. Examples from high precision depth-dose measurements are shown. (auth)

7866 (CONF-680920–, pp 944-50) TOXICITY OF THERMOLUMINESCENT PHOSPHORS. Dettmer, C. M.; Galkin, B. M. (Jefferson Medical Coll., Philadelphia, Pa. Stein Research Center).

The toxic effects of thermoluminescent phosphors in rats have been investigated by introducing these materials by means of ingestion, intraperitoneal insertion, and subcutaneous implantation. Ingestion of aqueous solutions of LiF proved fatal to 10 of 15 animals within 4 weeks. Gross symptoms of poisoning were reversed by allowing the animals to drink distilled water in place of the LiF solution. All of the phosphors tested produced adhesions when placed within the abdominal cavity. Subcutaneously implanted detectors caused local tissue reaction but did not appear to cause gross ill effects. Hot pressed and extruded forms of LiF were not recoverable 3 weeks after implantation. (auth)

7867 (CONF-680920–, pp 951-62) PERFORMANCE STUDY OF SOLID AND PREPACKAGED LiF DOSIMETERS. Suntharalingam, N. (Jefferson Medical Coll., Philadelphia, Pa. Stein Research Center).

The use of solid and pre-packaged LiF dosimeters for routine radiation dose measurements by mail has been investigated. The reliability of measurements using LiF Teflon discs, extruded rods, high sensitivity ribbons and sealed nylon capsules containing loose powder and the possible reuse of these dosimeters were studied. The precision of the different systems in repeatedly measuring exposures of 50-400R Cobalt-60 gamma radiation was comparable, being in the order of ±5%. Measurements with loose powder showed a precision better than ±3%. The results of the performance of each type of dosimeter are presented in detail. Also, their limitations and the precautions to be taken for re-use are discussed. (auth)

7868 (CONF-680920–, pp 963-75) SENSITIVITY CHANGES IN SOLID THERMOLUMINESCENT DOSIMETERS AFTER SUBCUTANEOUS IMPLANTATION. Galkin, B. M.; Dettmer, C. M.; Suntharalingam, N. (Jefferson Medical Coll., Philadelphia, Pa. Stein Research Center).

Several types of unencapsulated solid thermoluminescent dosimeters were implanted subcutaneously in rats and recovered after varying time intervals in order to check any effect of implantation on the TL response. Matrix embedded LiF dosimeters exhibited a loss in sensitivity following implantation. Extruded LiF dosimeters seemed to react with tissue fluid. They not only exhibited a loss in sensitivity but also dissolved in the animal when left in situ for about 3 weeks. The sensitivity of $Li_2B_4O_7$: Mn Teflon rods was not affected by the implantation. (auth)

7869 (CONF-680920–, pp 976-89) PHANTOM DEPTH–DOSE MEASUREMENTS WITH EXTRUDED LiF IN A LOW-EXPOSURE-RATE TOTAL-BODY IRRADIATOR. Beck, W. L.; Callis, E. L.; Cloutier, R. J. (Oak Ridge Associated Universities, Inc., Tenn.).

Extruded LiF dosimeters were used to measure the depth-dose distribution in a heterogeneous human-like phantom irradiated in the new low-exposure-rate total-body irradiator at the Medical Division of the Oak Ridge Associated Universities. In addition to the problems generally encountered in making such measurements, the nature of this irradiator posed several new ones because of its low exposure rate, large exposure volume, and multidirectional exposure pattern. Because of considerable scattered radiation, an energy-dependence problem was also encountered. To make depth-dose measurements in such a facility, a dosimetry system must be sensitive to small exposures, directionally independent, energy independent, and precise. Extruded LiF dosimeters were found to be well suited for this study. We have worked out techniques for handling, annealing, identifying, and individually calibrating these dosimeters. With these techniques, exposure measurements having standard deviations of about 1% are generally obtained. Isodose lines were determined from the point depth-dose measurements in the midlongitudinal and the midsagittal planes of the phantom. These lines show that the depth dose to the back region of the body is somewhat lower than near the front surface. They also show that the least dose is approximately 50% of the exposure at the treatment room center. Other depth-dose measurements have been made in specific volumes that are representative of particular organs in order to determine the average organ dose. (auth)

7870 (CONF-680920–, pp 990-9) THREE DIMENSIONAL DOSE DISTRIBUTION MEASUREMENTS IN THE HEAD AND NECK USING LiF. Mansfield, C. M.; Galkin, B. M.; Chow, M. C.; Suntharalingam, N. (Jefferson Medical Coll., Philadelphia, Pa. Stein Research Center).

Lithium fluoride powder and extrusions have been used in a phantom head to measure dose distributions from typical cobalt-60 teletherapy techniques. Measured doses in the central treatment plane have been compared with calculated values. Volume dose distributions have been determined. The reliability of thermoluminescent dosimetry for clinical applications has been demonstrated. (auth)

7871 (IDO–12068) SPECIAL APPLICATIONS OF THERMOLUMINESCENCE DOSIMETRY. Cusimano, John P.; Cipperley, Foster V.; Culley, John C. (Idaho Operations Office (AEC), Idaho Falls). June 1968. 13p. (CONF-680607–10). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

The results of recent experiments in thermoluminescence dosimetry are presented. A good gross integrated exposure correlation was indicated by a year-long exposure comparison field test using lithium fluoride-teflon dosimetry and beta-gamma film packets on ten high-exposure-probability individuals. Intercomparison of film, lithium fluoride-teflon discs, lithium fluoride phosphor, ferric sulphate solution, ionization chambers, R meters,

glass dosimeters and electroscopes similarly exposed to a gamma source showed a close correlation for shielded response. The average ratio of shielded film response to shielded lithium fluoride-teflon disc response for various distances from the source was 1.04 while the average ratio of unshielded or open-window film response to the disc was 2.1. Thermoluminescence dosimetry applications to the National Reactor Testing Station health physics program such as finger and hand dosimetry, shielding measurements, radiation source calibration, and use of thermoluminescence dosimetry as applied to doctors and nurses handling radiation accident victims are discussed. In a comparison of thermoluminescent dosimeters and film under actual criticality conditions the film saturated at approximately 650 R while the thermoluminescent dosimeters measured exposures in excess of 3,000 R close to the reactor package. (auth)

7872 (LA-4027) CHARACTERISTICS OF MINIATURE AND TEFLON LiF THERMOLUMINESCENT DOSIMETERS. Valentine, Allen M. (Los Alamos Scientific Lab., N. Mex.). Oct. 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Basic characteristics of two LiF thermoluminescent dosimeter (TLD) systems are presented. They include photon exposure response for miniature and 0.5-mm Teflon disc TLD's, in-air photon energy response for miniature and 0.5-mm Teflon disc TLD's, photon energy response for 0.5-mm Teflon disc TLD's packaged in rubber finger rings, heater current response for 0.5-mm Teflon disc TLD's, and source-to-detector distance response for a miniature ^{6}LiF, 10-in. polyethylene sphere system. (auth)

7873 (NP-tr-1720) A METHOD OF REDUCING THE ENERGY DEPENDENCE OF THE DOSE SENSITIVITY IN MEASUREMENTS OF γ-DOSE RATES USING RELEASE COUNTERS. Schwaar, L.; Entress, G. Translated by D. Verdin (Atomic Energy Research Establishment, Harwell, Eng.), from Kernenergie, 6: 617-21(1963). 11p. Dep. CFSTI.

A method which permits a reduction in the energy dependence of release counters in the measurements of dose rates is described. This can be achieved by using an absorber which is constructed, for example, axially symmetric to the counter and which has different thicknesses along the axis of the counter. A procedure for designing such absorbers is given and the capability of the method is demonstrated for a practical example. (auth)

7874 NEW POSSIBILITIES FOR ROUTINE USE OF OXALIC ACID SOLUTIONS IN IN-PILE DOSIMETRY. Markovic, V.; Draganic, I. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Radiat. Res., 36: 588-600(Dec. 1968).

New data are given on the use of oxalic acid, in light and heavy water solutions, for in-pile chemical dosimetry. The method of calculating the absorbed doses in low-Z materials is described. Results of chemical measurements in the core of the heavy-water-moderated reactor at Vinča (Yugoslavia) are compared with the results of calorimetric measurements conducted under identical conditions. (auth)

7875 SOME NEW ASPECTS ON THE USE OF THE OXALIC ACID DOSIMETER. Holm, N. W. (Danish Atomic Energy Commission Research Establishment, Risoe); Draganic, I. G. Atompraxis, 14: 495-7(Nov.-Dec. 1968).

The development of the oxalic acid dosimeter is reviewed. It is considered by many as a quite troublesome system. The system has a wide dose range (1 to 100 Mrad); it can be used at electron dose rates up to above 10^{10} rad/sec; it is not activated significantly when subjected to a neutron flux; it is highly accurate, when properly calibrated, and it is perfectly water equivalent. The decomposition follows first order reaction kinetics thereby permitting the use of a simple mathematical relation between decomposition and absorbed dose. The decomposition yield is not fully independent of the irradiation conditions, but when the system has been calibrated under actual working conditions, it will render excellent results. (auth)

7876 RESULTS OF THE RESEARCH ON THE USE OF PHOTO-CONDUCTIVE CELL IN X-RAY DETECTION. Lanzi, G.; Mazzoleni, G. F. (Univ., Pavia, Italy). Radiobiol. Radioter. Fis. Med., 23: 141-8(Mar.-Apr. 1968). (In Italian).

In order to complete previous researches upon the possibility of the use of a photoconductive cell in x-ray detection, a critical review was carried out on the possible uses of this device for x-ray dosimetry. (auth)

7877 GAMMA DOSIMETRY WITH FLUOROCARBONS. Jeltsch, E. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 11: 307-8(Oct. 1968). (In German).

The use of radiochemical changes in fluorocarbons for γ dosimetry was tested by three different methods. The surface hardness of polytetrafluoroethylene was measured as a function of the γ dose. The amount of radiolytic products formed from each gram of starting material as a function of γ dose was determined. The viscosity as of a function of dose was shown for three fluorocarbons. (J.S.R.)

7878 THERMOLUMINESCENT DOSIMETRY AS PERSONNEL MONITORS. Nakajima, Toshiyuki. Nippon Genshiryoku Gakkai-shi, 10: 686-93(1968). (In Japanese).

Work on the thermoluminescent dosimeter is described under the headings of principles applied, characteristics, and comparison with other personnel monitors. It is shown that the purpose of the personnel monitors is to estimate at least the dose absorbed in each critical organ. It is possible to achieve this by using several thermoluminescent dosimeters simultaneously as personnel monitors. (auth)

7879 TWO-PIECE RADIATION DETECTOR OF THE POCKET DOSIMETER TYPE. Frank, John P. (to Bendix Corp.). U. S. Patent 3,411,005. Nov. 12, 1968. Filed July 27, 1964.

A two-piece radiation detector having an eyepiece assembly which is removable from the radiation transducer and electrometer assembly is described. (TSS)

7880 RADIATION DETECTION WITH NON-SILVER HALIDE FILM. Takahara, Hikaru (Chiba Univ., Japan); Iida, Hiroyoshi. Chiba Daigaku Bunrigakubu Kiyo, Shizenkagaku, 5: No. 1, 51-2 (Nov. 1967). (In Japanese).

The x- and gamma-ray sensitivity of non-silver halide light-sensitive film (Kalver film) was studied for radiation dosimetry. In the x-ray dose range up to 200 R, no detectable light-sensitive density was obtained. For gamma-rays, the detection of up to 10^{6} R was possible with intensifying screens, but the film alone showed no light-sensitivity effect. While the Kalver film has the advantages of no chemical treatment and no use of the dark room, the sensitivities for both x- and gamma-rays are low, its use being limited only to the large doses. (NSA of Japan)

7881 NEW METHOD FOR γ-RADIATION DOSIMETRY. Klamerth, O. L.; Kocsis, F. J. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Int. J. Radiat. Biol., 14: 293-5(1968).

A method for gamma-ray dosimetry based on the formation of malondialdehyde during irradiation of aqueous glucose solution or other polyhydroxy compounds is described. (B.G.D.)

Radiometric Instruments

Refer also to abstracts 7631 and 7704.

7882 MICROANALYSIS OF SURFACES BY SCANNING WITH CHARGED PARTICLE BEAMS. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Nucl. Instrum. Methods, 67: 1-8(Jan. 1, 1969).

Particle beams produced in high-voltage accelerators have been reduced in area by collimation and used to irradiate localized regions of a sample surface. By measuring elastically scattered particles or prompt γ-radiation, the change in thickness of a surface layer or the variation in elemental composition across several different samples has been examined. (auth)

7883 RADIATION MEASURING SYSTEM. Mills, William R. Jr. (to Mobil Oil Corp.). U. S. Patent 3,413,473. Nov. 26, 1968. Filed Nov. 29, 1963.

The design of a radiometric well logging system is described. The system includes a pulsed neutron source, a radiation detector with gating circuits, and a recording system. (W.H.K.)

7884 PRESENT STATE OF MEASURING INSTRUMENTS USING RADIATIONS. Otsuka, Iwao (Inst. of Physical and Chemical Research, Tokyo). Otomeshon, 13: No. 8, 10-14(Aug. 1968). (In Japanese).

The present state of measuring instruments using radiations are described in the following: merits and demerits of the measuring instruments using radiations; principles of the instruments, including thickness, level, density, moisture, snow precipitation, and vacuum meters; the state of their utilization; the recent trends in development of the instruments for on-line use, use of americium-241, sulfur analyzing device, fluorescent X-ray analysis, smoke etc. detectors. (NSA of Japan)

7885 ALPHA RAY EXCITED COMPOSITION ANALYSIS. Sellers, Francis B.; Ziegler, Charles A. (to Parametrics, Inc.). U. S. Patent 3,408,496. Oct. 29, 1968. Filed Nov. 23, 1964.

A system for determining the elemental composition of a material is described. Alpha particles are used to excite the characteristic x-rays from the material and a detector which can discriminate between different energy levels is used to provide an output indication of the quantity of x-rays which are characteristic of specific elements. (U.S. Pat. Gazette)

Miscellaneous Instruments and Components

Refer also to abstracts 7926, 9173, 9182, and 9183.

7886 (CEA-R-3546) CONSTRUCTION OF AN ENERGY SELECTOR FOR SLOW ELECTRONS. Chatel, Serge (Commissariat a l'Energie Atômique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 42p. (In French). Dep.

After a presentation of the principles on which are built homokinetic electron selectors and the difficulties peculiar to low energies, a review of the equipment built is given. The apparatus described uses a cylindrical condenser with an angle of $\pi/2$. It can be fitted to a mass spectrometer. The measurements carried out with an analyzer identical to the selector show the separating power to be between 0.12 and 0.14 eV for energies of between 6 and 42 eV. (auth)

7887 (CNEA-218) MICRO X-RAY DEVICE. Cannistraci, Carlos A.; Karpeles, Alfredo; Tenreyro, Elma A. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 20p. (In Spanish). Dep.

The characteristics and applications of a micro x-ray device applicable for intracavity exposure measurements are presented. The radiation source is a sealed capsule containing ^{125}I. The method for obtaining a source of ^{125}I by electrodeposition on silver is described. The microdevice is a portable unit whose operation does not depend on the supply of electric energy being sufficiently small to permit its intracavity placement. Radiographs obtained with the unit in the oral cavity, the nasopharnyx, and the external auditory meatus were presented and possible applications of the unit in radiotherapy and radiodiagnostics were suggested. The intracavity placement of the radiation unit reduces, and in many cases eliminates, the superposition of structure in the radiographic image. The use of specially designed collimators makes it possible to obtain a very fine beam of x-rays, increasing the resolution in some cases. Other types of collimators produce x-ray beams which permit an irradiation in all directions transverse to the source, with aperture of the irradiation plane greater than 120°. (tr-auth)

7888 (EUR-4062) DEVICE FOR BURNOUT DETECTION WITH LOCALIZATION FOR dc-HEATED INDIVIDUAL PIPES AND BUNDLES. Herzberger, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 6, 1968. 12p. (In German). Dep.

Description is given of an electronic equipment for burn-out detection with possibility of its localization. The apparatus can be used for rod bundles. In the case of 6 tubes it is possible to localize in two parts, for a single tube in 12 parts. The localization is indicated by a light signal. Contemporaneously the system is used to protect the tube or the bundle commanding a high speed circuit breaker which cuts down the main power. (auth)

7889 (MORP-68-9) DEVELOPMENT AND EVALUATION OF AN AUTOMATIC COLLIMATOR FOR MEDICAL DIAGNOSTIC X-RAY MACHINES. Walchle, Ray L.; Stewart, Harold F.; Morel, Joseph M. (National Center for Radiological Health, Rockville, Md.). Aug. 1968. 9p.

The design of the second prototype of an automatic collimating system for diagnostic x-ray machines is described. Results of a clinical evaluation of this prototype are discussed and the resulting improvements are described. In its present design the collimator can automatically provide optimum collimation for the types of examination which account for about 75% of the number of diagnostic medical radiographs on a national basis. The system, which utilizes a commercially available motorized collimator, may be installed on any X-ray unit which will accept the motorized collimator. (auth)

7890 (ORNL-tr-2024) EXPERIMENTAL INVESTIGATION OF THE THERMAL EFFECT OF THE ELECTRON BEAM ON THE OBJECT IN THE ELECTRON MICROSCOPE. Stojanowa, I. G.; Belawzewa, E. M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Int. Kongr. Elektronenmikrosk., 4. Berlin, 1958, Verh., 1: 100-3(1960). 5p. Dep. CFSTI.

In order to study the thermal action of an electron beam on an object in an electron microscope, a microthermocouple was developed to make exact measurements on the object. (B.G.D.)

7891 (RISO-M-785) DEVELOPMENT OF TEMPERATURE- AND CONDUCTIVITY-COMPENSATED IMPEDANCE VOID DETECTOR. Nielsen, Dan S. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1968. 37p. Dep.

A temperature- and conductivity-compensated impedance void detector which provides a means of measuring local void fractions in two-phase flow under subcooled-boiling conditions has been developed. Details of the design and operation of the detector are presented with out-pile and in-pile results. (auth)

7892 (UCRL-18530) COMPUTER-BASED SYSTEM FOR THE NUCLEAR DATA COMPILATION "TABLE OF ISOTOPES". Lederer, C. M.; Hollander, J. M.; Meissner, L. P. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1968. Contract W-7405-eng-48. 36p. Dep. CFSTI.

A fully computer-based system for producing future editions of the Table of Isotopes is described. (W.H.K.)

7893 (Y-1658) SPHERICAL INTERFEROMETER WITH WHITE-LIGHT COMPENSATION. Baldwin, R. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Dec. 24, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A modified form of a white-light-compensated Twyman–Green interferometer has been recently developed which can determine both the size and sphericity of concave spherical surfaces. The interferometer has an included field of view in excess of 110° and will accommodate any specularly reflective concave spherical surface two inches or less in radius. Expected accuracy of the interferometer is ±5 microinches for both size and sphericity, and repeatability should approach ±1 microinch. (auth)

7894 USE OF COMPUTERS IN HIGH ENERGY PHYSICS EXPERIMENTS. Lord, D.; Macleod, G. R. (CERN, Geneva). J. Phys., E (London), 2: 1-9(Jan. 1969).

An introductory description is given of the nature of high energy physics experiments and of the characteristics of the detectors employed, together with the main uses of computers in this field. A more detailed review is made of the role of computers in film measurement and data taking methods, indicating the limitations set by present computing techniques and some future trends to be expected. (auth)

7895 NUCLEAR MAGNETIC RESONANCE SPECTROMETER USING A SUPERCONDUCTING MAGNET. Haliday, J. D.; Hill, H. D. W.; Richards, R. E. (Oxford Univ.). J. Phys., E (London), 2: 29-32(Jan. 1969).

A versatile nuclear magnetic resonance spectrometer using a superconducting magnet is described. Details of the magnet are given and the important features of the spectrometer are described. A novel probe design is discussed and examples of the spectrometer performance are given. (auth)

7896 CONVERSION OF AN AUTOMATIC SLIDE PROJECTOR TO TRANSPORT RADIOACTIVE FOILS TO A PAIR OF COUNTERS. Grose, K. D.; Hancox, N. L. (Univ. of Birmingham, Eng.). J. Phys., E (London), 2: 105(Jan. 1969).

The conversion is described of an automatic slide projector to make a foil transporter for carrying radioactive (β) foils to a pair of counters. (auth)

7897 USE OF A TUNNEL DIODE AS AN AMPLITUDE DISCRIMINATOR AND ZERO CROSSING DETECTOR. Remigolsky, B. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods, 67: 9-12(Jan. 1, 1969).

Circuits are described for utilizing a tunnel diode as a discriminating element as well as a zero crossing point detector. When driven by slow DDL pulses, the circuits have a time slewing of less than 1 ns for 0.35–10 V input pulses. For fast pulses in the range of 0.7–12 V the time slewing is better than 200 ps. (auth)

7898 FAST LINEAR GATE. Conrad, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 67: 153-6(Jan. 1, 1969). (In German).

A fast bipolar, dc-coupled linear gate is described. It is built as a switch-over-gate. The switching time is about 3 ns. It was developed for gating fast zero-crossing time signals in nuclear experiments. The input and output impedance is 50 Ω, the maximum amplitude ±2 V. (auth)

7899 ANALYSIS OF FOUR-STAGE APERIODIC RF MASS ANALYZER. Lall, H. B.; Mathur, R. N. (Central Scientific Instruments Organisation, Chandigarh, India). Nucl. Instrum. Methods, 66: 114-18(Dec. 1, 1968).

Theoretical analysis for the identification and separation of positive as well as negative ions with a four-stage aperiodic radio-frequency mass spectrometer is given. The basic equations of the energy-modulating function, resolving power and current efficiency are obtained. The expressions for the dependence of the resolving power and current-efficiency of the analyzer, on different variables have been obtained. The selection for the free-drift spaces and their cycle choice is discussed. (auth)

7900 TRANSLATABLE SUPPORT FOR MOVING THE VACUUM SYSTEM AND THE MASS SPECTROMETER RELATIVE

TO THE MAGNET. Erickson, Raymond A. (to Varian Associates). U. S. Patent 3,401,405. Sept. 10, 1968. Filed Apr. 4, 1966.

A mass spectrometer system is disclosed. The mass spectrometer includes an ion mass analyzer chamber disposed in the magnetic gap of a magnet. The magnet includes a yoke structure interconnecting the poles of the magnet and bridging across the magnetic gap. A vacuum system, including a pair of vacuum pumps and a rigid exhaust manifold, is connected to the mass analyzer chamber for evacuating the chamber. A hanger structure is affixed to the yoke of the magnet for supporting the mass analyzer and vacuum system. A movable carriage supports the vacuum system and mass analyzer from the hanger structure. The movable carriage includes a pair of parallel rods passable through and axially slidable through the hanger structure. The support rods have a sufficient length such that the full extent of movable travel of the carriage is sufficient to move the mass analyzer chamber substantially out of the gap of the magnet to facilitate access to the mass analyzer. Adjusting screws are provided on the hanger structure for producing small adjustments of the position of the mass analyzer within the gap of the magnet. (auth)

7901 CALCULATION OF THE STRAY FIELD OF MAGNETS WITH POISSON. Halbach, K. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 66: 154-6(Dec. 1, 1968).

It is shown that application of conformal mapping to two dimensional magnets, containing iron with nonlinear B(H) characteristics, allows calculation of magnetic fields in all 2D space. For some magnets of finite length, this information can be used to get a good approximation for the stray fields in all of 3D space. It is furthermore shown that only minor modifications to POISSON are necessary to allow application of the same techniques to magnets with axial symmetry, leading in this case to solutions that genuinely and accurately describe the fields in all of 3D space. (auth)

7902 SOFTWARE CONTROLLED MULTIPLE SCANNER FOR NUCLEAR EXPERIMENTS. Colombo, G.; Coppo, N.; Stanchi, L. (Joint Nuclear Research Center, Ispra, Italy). Nucl. Instrum. Methods, 67: 116-20(Jan. 1, 1969).

A very simple instrument which allows to scan step by step up to six quantities during a nuclear experiment is described. Steps are controlled by a software program read by the reader of a popular teletypewriter. Software program allows to change the value of successive steps without human presence. Moreover the instrument can be used in a general way for different experiments. The principle of the operation is described with some circuit details and some applications are exemplified. (auth)

7903 ANALYSIS OF RANDOM COINCIDENCES IN MEASUREMENT WITH TIME-TO-PULSE HEIGHT CONVERTERS. Braunsfurth, J.; Rueter, D.; Winkler, H. (Univ., Hamburg). Nucl. Instrum. Methods, 67: 45-55(Jan. 1, 1969). (In German).

Background in time spectra obtained with time-to-pulse height converters has been investigated. Evidence is given, that with total counting rates exceeding 10^4/sec an important part of this background consists of chance coincidences of higher order. Means for optimizing the signal-to-noise ratio in the time spectra were found in the reduction of the resolution times of the fast-slow coincidence system. An improvement of one order of magnitude over conventional systems has been obtained. (auth)

7904 REACTOR PERIOD METER. Kaneko, Eiji (to Hitachi Ltd.). Japanese Patent 1968-18512. Aug. 8, 1968. Filed Feb. 15, 1965.

A completely digital period meter is described which eliminates the error operation caused by noise. There is no delay time, and the instrument has good stability. (TSS) (NSA of Japan)

7905 CONTINUOUS SMOOTHING OF SPECTRA IN A MULTICHANNEL ANALYSER USED FOR MOESSBAUER STUDIES. Clark, P. E. (Univ. of Exeter, Eng.). Nucl. Instrum. Methods, 67: 164-8(Jan. 1, 1969).

A method is described in which Moessbauer spectra are obtained by first converting the pulses from a gamma ray detector into an analog signal and then using a multichannel analyzer to sample this signal at regular intervals. By the inclusion of a suitable filter in the analog part of the circuit the effect of subsequent smoothing of the spectrum with a desired smoothing function may be simulated. It appears that this method offers greater speed and convenience in operation with the possibility of using counting rates not limited by the resolving time of the multichannel analyzer. (auth)

7906 CALIBRATION OF AN EXCITED NUCLEAR STATE g-FACTOR IN TERMS OF THE PROTON g-FACTOR. Bleck, J.; Haag, D. W.; Ribbe, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 67: 169-72(Jan. 1, 1969).

An apparatus is described which measures differentially in time the Larmor frequencies of both protons and excited nuclei in the same magnetic field with the same time-to-pulse height converter by transforming oscillations of the proton precession into a periodic variation of a pulse counting rate. Applied to the 198-keV $5/2^+$ state of ^{19}F this method gave an accuracy of 0.2% for the ratio of the Larmor frequencies. The value for the $^{19}F^*$ g-factor is $g = 1.442 \pm 0.003$. (auth)

7907 BEAM HANDLING BEHIND AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Dulfer, G. H.; Caspers, N. A.; Verheul, H. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods, 67: 179-80(Jan. 1, 1969).

Beam handling using two magnetic quadrupole lenses behind a double focusing isotope separator yields a line-focus with a width of 0.6 mm. A spot-focus can be obtained too. With this technique it is possible to take a beam of radioactive ions out of the collector-chamber to a measuring-facility. Beamscanners proved to be very useful for measuring the beam profile and the position of the beam in the transport-tube. A focus can be shifted in the beam direction over a distance of 30 cm by moving the quadrupole lenses, without serious defocusing. (auth)

7908 DEVICE FOR CONTINUOUSLY MEASURING THE TEMPERATURE OF HOT MEDIA. (to Vereinigte Oesterreichische Eisenund Stalwerke Aktiengesellschaft. Metallwerk Plansee Aktiengesellschaft). British Patent 1,137,432. Dec. 18, 1968. Priority date Apr. 12, 1965, Austria.

A device for continuously measuring the temperature of hot media in reaction vessels is described. The device consists of a tube which penetrates the wall of the vessel and encloses a thermocouple, an end, or closing, member which closes the tube level with the inner wall of the hot vessel, and a thermocouple. The tube is made of a metal-ceramic material which is heat-proof and resistant to the influence of the hot medium. The material of the closing member has both these characteristics plus good thermal conductivity. The hot junction of the thermocouple may be arranged in, on, or behind the closing member. The device is said to have little or no lag in temperature indication and cannot be damaged by material in the reaction vessel. (L.C.L.)

7909 DETECTOR PROBE FOR MEASURING VOIDS IN THE REACTOR CORE. Satomi, Masahiro (to Hitachi Ltd.). Japanese Patent 1968-18656. Aug. 13, 1968. Filed July 21, 1964.

The advantages of the method proposed are its resistance to the high temperature and high pressure, and complete insulation from the high-temperature and high-pressure water. The detector consists of two hollow inner and outer cylinders of aluminum oxide. On the outside of the inner cylinder is cut a spiral groove in which a coil is placed; the coil between the two cylinders is sealed. The outlet of the coil is also fixed and sealed by a filling material. (NSA of Japan)

7910 IMPROVEMENTS IN OR RELATING TO PRESSURE DEVICES. Davidson, John (to Babcock and Wilcox Ltd.). British Patent 1,134,101. Nov. 20, 1968. Filed Sept. 1, 1964.

A pressure responsive apparatus is described comprising a cylindrical vessel closed except for an inlet orifice for connection to a source of gas/solid suspension and an outlet orifice connected to a pressure gauge. A filter extends transversely to the axis of the cylinder, dividing the cylinder into two parts, the inlet chamber volume being preferably seven times that of the outlet chamber. The characteristics of the filter are such as to prevent the passage of particles exceeding a general maximum size. A particular application would be in the measurement of pressure drop in the heat transfer circuit of a nuclear reactor. A detailed example is given where the coolant is graphite-loaded carbon dioxide gas. (UK)

7911 IMPROVEMENTS IN OR RELATING TO LIQUID LEVEL GAUGES. Cornish, Donald Nelson (to United Kingdom Atomic Energy Authority). British Patent 1,135,485. Dec. 4, 1968. Filed May 26, 1966.

A liquid level gauge is described suitable for use in cryostats containing liquids, such as helium, of sufficiently low temperatures to induce superconductivity in a superconducting material immersed in the liquid. The gauge consists of a loop of superconducting wire, such as niobium/25% zirconium, partly immersed in the liquid and partly above. A fall in the liquid level is indicated by a fractional increase in the total resistance of the superconducting wire. An electrical heating coil is mounted near the upper end of the wire to raise the temperature of the upper end above its critical temperature. (UK)

7912 IMPROVEMENTS IN OR RELATING TO VIDEO-SIGNAL DIGITISERS. Hooton, I. N.; Best, G. C.; Lewis, A. (to United

Kingdom Atomic Energy Authority). British Patent 1,133,761. Nov. 20, 1968. Filed Mar. 31, 1965.

A video-signal digitizer is described for producing in digital form information contained in a photograph, or the like, and comprising means to produce from a video signal representing the photograph binary words representing elements of the photograph which have characteristic features; means are incorporated to sample the video signal at random intervals at a frequency such that the words are produced at a low rate relative to the rate at which the elements occur in the video signal. The digitizer may be used to resolve the information contained in a photograph of a nuclear event into digital form for an analyzer. (UK)

7913 IMPROVEMENTS IN TUBE WALL THICKNESS MEASURING GAUGES. Campsie, Ian Cochran; Rattray, Hugh Dow (to United Kingdom Atomic Energy Authority). British Patent 1,135,386. Dec. 4, 1968. Filed May 17, 1965.

The gauge described consists of a rod-like light guide, of quartz or plastic, supported at one end and free at its other end, to be inserted inside the tube whose wall thickness is to be measured. Cradle points are provided to support the tube with the light guide inserted, and there is a reference support contacting the tube at the external point where the wall thickness is to be measured, the light guide having a radial feeler projection at the free end so that the feeler projection bears on the inside of the tube at the same point internally. The light guide is illuminated at the fixed end and a viewing device is provided for measuring, from outside the tube, the deflection of the end face of the free end of the light guide from a reference position. (UK)

7914 IMPROVEMENTS IN OR RELATING TO COLD CATHODE GLOW DISCHARGE DEVICES. Maskell, C. W. A. (to United Kingdom Atomic Energy Authority). British Patent 1,134,407. Nov. 20, 1968. Filed July 16, 1965.

The device described comprises an enclosure, maintained at low gas pressure, and containing an anode, a hollow cathode electrode assembly, one end of the cathode being circular in shape, with a further electrode electrically insulated from the cathode and also being circular shaped at one end, this further electrode being adjacent to, but spaced from, the cathode to provide a gap. Means are provided to apply suitable operating potentials to the anode, cathode, and further electrode. During operation a glow discharge occurs and streams of electrons pass through the gap and converge on the axis of the electrode assembly. Such devices can be used, for example, for the heat treatment, welding, drop melting or zone refinement of refractory materials. (UK)

7915 MULTIPOLE MASS FILTER. Brubaker, Wilson M. (to Bell and Howell Co.). U. S. Patent 3,410,997. Nov. 12, 1968. Filed Sept. 8, 1964.

A multipole mass filter for selectively detecting charged particles comprising of a source of charged particles, a plurality of substantially parallel first electrodes symmetrically disposed about a central axis, said electrodes being laterally spaced about the central axis electrodes, a source of ac voltage, means coupling the first electrodes to the ac voltage to create an alternating multipole electric field component between the electrodes, a source of dc voltage, means coupling the first electrodes to the dc voltage to create a static multipole electric field component between the electrodes, a plurality of second electrodes disposed in spaced relation to the exit end of the first electrodes, the second electrodes having a portion thereof adjacent the exit end of the first electrodes disposed in alignment with relation to the first electrodes and the central axis of the first electrodes and a portion thereof remote from the exit end of the first electrodes disposed out of alignment with relation to the central axis of the first electrodes, a collector disposed adjacent the exit end of the second electrodes, and means for connecting the plurality of second electrodes to a source of deflecting voltage for diverting the trajectory of a charged particle beam emerging from the exit end of the first electrodes. (U.S. Pat. Gazette)

7916 ELECTRICAL CONTROL CIRCUIT FOR A SCANNING MONOPOLE MASS ANALYZER. Watters, Robert L. (to General Electric Co.). U. S. Patent 3,410,998. Nov. 12, 1968. Filed Jan. 21, 1965.

An electrical control circuit for supplying a regulated voltage to a monopole mass analyzer or filter capable of sweeping through a mass range of up to 600 to 1 includes an oscillator for generating an alternating voltage, a voltage divider for sampling a portion of the alternating voltage, a rectifier for transforming the sample portion into a unidirectional voltage, a servo circuit for regulating the unidirectional voltage to a preselected and selectable fraction of the alternating voltage and a sweep circuit for simultaneously sweeping the absolute values of the unidirectional and alternating voltages through a preselected range without altering the relative values of the alternating and unidirectional voltages to one another. (U.S. Pat. Gazette)

7917 DESIGN AND CHARACTERISTICS OF PRESENT-DAY PHOTOMULTIPLIERS. Pietri, G.; Nussli, J. (Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes, France). Philips Tech. Rev., 29: 267-87(1968).

The manufacture of photomultipliers now encompasses an astonishing variety of types of tube, in which attention is paid to the requirements of widely different applications. After a description of the general principles underlying the design of photomultipliers and their characteristics, the article examines the statistical effects that limit the performance of photomultipliers, in relation to the introduction of noise and speed response. It is shown how the study of these effects gives a better understanding of the relations existing between the various parameters and leads to an overall optimization of performance. Thus, the appropriate use of high electric fields, which give a high speed of response but tend to increase the dark current, has resulted in a pulse response of nearly 1 ns in the fastest photomultipliers, and a transit-time fluctuation of nearly 0.1 ns. A description is also given of several of the newest developments such as heterodyne detection of modulated light, and the concluding section indicates the probable trends of future development. (auth)

7918 METHOD FOR DETECTING THE POSITION OF A CONTROL ROD IN THE SEALED VESSEL. Abe, Yasuhiro (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1968-16438. Julv 10, 1968. Filed Feb. 26, 1966.

By the method proposed, the device for detecting the control-rod position in the sealed vessel can be obtained economically, also eliminating the drawbacks in the similar conventional methods. It consists of the following: the sealed vessel, containing a control-rod drive rod; a magnetic-material member, connected to the end of the drive rod through a spring; a spring, connected to the member in series with the other spring; and, coils, located externally, for detecting the control-rod position by means of the movement of the member. The ratio of the movements of the member and the control-rod drive rod is made given based on the ratio of the constants of the two springs. (NSA of Japan)

7919 MICROWAVE TECHNIQUES FOR MEASURING HIGH TEMPERATURES AND COOLANT IMPURITIES. Billeter, T. Roger; Brown, D. P.; Spear, W. G. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl., 6: 73-80(Jan. 1969).

Techniques and instrumentation at microwave frequencies show promise for measuring both temperature and gas coolant impurities within high temperature nuclear reactors. Temperature is measured as a result of the thermal expansion of a metallic sensor, while impurities can be detected by their effect upon the coolant dielectric constant. An experimental Ni–Cr steel microwave cavity, resonant at 15 GHz, yielded a linear output signal for variations of temperature to 1,250°C with a sensitivity of 330 kHz per degree C. For gas coolant impurity measurements, both a microwave cavity method and a phase shift method provided desired speed-of-response and sensitivity. Tests with the interferometer-type impurity measuring instrument indicate a sensitivity of $\sim 4 \times 10^{-4}$ degrees phase shift $(\text{ppm})^{-1}\text{m}^{-1}$ for water vapor in helium gas and a time constant of one second for step changes in impurity content. (auth)

7920 ELECTRONIC EQUIPMENT AND TECHNIQUES IN NUCLEAR MEDICINE. Brooks, S. S. Research, 1: 22-4(Sept.-Oct. 1968).

A brief review is given under the following headings: Radioactive tracers; equipment requirements; counting systems; measuring the function of an organ; instruments for detecting cancer; gamma camera; and scintiscanners. (U.K.)

7921 IMPROVEMENTS IN OR RELATING TO NEUTRON SENSITIVE CAMERA TUBES. Daniels, Werner Rene (to Twentieth Century Electronics Ltd.). British Patent 1,133,971. Nov. 20, 1968. Filed Jan. 7, 1966.

A neutron sensitive camera tube is described in which a target is scanned by an electron beam to produce electrical signals representative of the image observed by the target. The target comprises three layers: a backing layer of low neutron absorption; an intermediate layer of material (e.g., boron 10 or gadolinium) which emits corpuscular radiation such as α and β particles when reacting with neutrons; and a third layer of high initial resistivity having the property known as bombardment induced conductivity (e.g., amorphous selenium). In operation, neutrons reaching the target pass through the first layer and, impinging on the intermediate layer, cause the generation of corpuscular radiation which, in turn, causes a voltage pattern of the image seen by the target to appear on the outer face of the third layer. The

analyzing electron beam thereupon causes an electronic signal to be fed to the tube output circuit. (UK)

7922 DEVICE FOR TRANSMITTING ELECTRICAL MEASUREMENTS. Charlade, Jean (to Commissariat a l'Energie Atomique). British Patent 1,136,278. Dec. 11, 1968. Priority date June 23, 1965, France.

Contact studs for the ends of reactor fuel elements in a horizontal position are described which ensure electrical contact between instruments inside the reactor and associated equipment outside the reactor during operation, i.e., at high temperature. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 8679.

7923 (BNWL-788) EFFECT OF ^{60}Co IRRADIATION ON PASSIVATED AND NONPASSIVATED AVALANCHE DIODES BIASED NEAR BREAKDOWN. Hoitink, N. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 51p. Dep. CFSTI.

Irradiation of the same type of passivated and nonpassivated avalanche diodes was observed to produce significantly different effects. Irradiation in a 2×10^6 R/hr, ^{60}Co gamma field, with the diodes biased at 5% below breakdown permitted investigation of the effects on multiplication mode operation, a mode possibly suitable for application of diodes as radiation detectors. During the experiments, encapsulated diodes and those with the container removed but with vacuum applied received exposures up to 1.4×10^8 R. Comparison of performance in the gamma field indicated passivated diodes to possess superior operational characteristics, particularly for stability and predictability of the reverse current, both with and without encapsulation. The nonpassivated devices evidenced continuous changes in reverse current, especially with the encapsulation removed. Operational recovery of passivated diodes with bias applied occurred quickly following physical removal from the gamma field. Similar recovery for the nonpassivated diodes required removal of the bias voltage. Analysis of the experimental results indicated that surface effects contributed substantially to the major changes in characteristics of the diodes. (auth)

7924 SOLAR CELL INTEGRAL COVERSLIPS. Solomon, S. J.; Harrison, S.; King, W. J. (Ion Physics Corp., Burlington, Mass.). pp 132-42 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

The radiation protection function of solar cell integral coverslips is discussed. Choice of coverslip material is restricted to fused silica, sapphire, and microsheet (Corning No. 0211). (W.D.M.)

7925 SOLAR CELL RADIATION STUDIES. Brancato, Emanuel L. (Naval Research Lab., Washington, D. C.). pp 156-67 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

The principle of the solar cell is outlined. The nature of the space radiation and its damage to solar cells and cover glass is described. Supporting data are presented on the effects of electron and proton radiations on silicon p/n, n/p solar cells. The influence of the base resistivity on radiation hardness of the solar cell is described. The behavior of cell cover, transparent adhesives under radiation is investigated. (auth)

7926 METHOD AND APPARATUS FOR MINIMIZING THE EFFECTS OF IONIZING RADIATION ON SEMICONDUCTOR CIRCUITS. Crowe, John W. (to North American Rockwell Corp.). U. S. Patent 3,409,839. Nov. 5, 1968. Filed Aug. 4, 1965.

A method for at least partially eliminating the effects of a photocurrent induced in a semiconductor junction in a circuit by ionizing radiation incident thereon is described. It consists of generating a compensating current in response to ionizing radiation which is essentially equal to said induced photocurrent and introducing said compensating current into said circuit to essentially neutralize the effects of said induced photocurrent in said semiconductor. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 7866, 7974, 7985, 8009, 8016, 8032, 8048, 8063, 8065, 8067, 8090, and 8096.

7927 (COO-690-32) RADIATION EFFECTS IN BIOCHEMISTRY AND ORGANIC CHEMISTRY. Technical Progress Report Covering the Period From October 15, 1967–October 14, 1968. (Colorado Univ., Boulder). July 10, 1968. Contract AT(11-1)-690. 49p. Dep. CFSTI.

ASPARTATE CARBAMOYLTRANSFERASE—analysis for protein species

GAMMA RADIATION—effects on activity of aspartate transcarbamylase in solid state, effects of absorbed dose and substrate concentration on

LYSOZYME—radiation effects on native, chromatographic separation of protein species produced during cesium-137 γ

—reactions with tritium-labeled hydrogen sulfide

—radiation effects on native, denaturation studies of protein species produced during cesium-137 γ

—radiation effects on hydrogen-exchange rate and perturbation spectra of, γ (E.R.B.)

7928 (COO-1634-3) EFFECTS OF IONIZING RADIATION ON A MONOLAYER OF CELLS. Final Report. Stadelmann, E. J. (Minnesota Univ., St. Paul. Dept. of Horticultural Science). Sept. 1, 1968. Contract AT(11-1)-1634. 60p. Dep. CFSTI.

The effects of various doses of α- and β radiation on water permability in a monolayer of epidermal cells from dormant and growing onion bulbs (Allium cepa) were studied. Methods used for cell preparation, irradiation techniques, and estimates of permeability time are described. Results showed that permeability increased with increased radiation dose. Data are included on the effects of various treatments ($CaCl_2$,KCl) of the cells on water permeability, and preliminary data are included on the effects of radiation on the permeability constants of several permeating non-electrolytes. (C.H.)

7929 (INR-921) SIGNIFICANCE OF THE INTRACELLULAR DISTRIBUTION OF ENZYMES IN EARLY CHANGES OF THEIR ACTIVITIES AFTER IRRADIATION "IN VIVO". Dancewicz, Antoni M. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 66p. (In Polish). Dep.

Results are presented from studies of the effects of ionizing radiation on the activities of enzymes in rat liver and spleen. The activities were measured immediately, 2 hr, and 24 hr after exposure of animals to a dose of 750 R of x rays. Simultaneously, contents of -SH groups and of lipid peroxides in organs of irradiated animals were determined. Enzyme activities assayed in tissue homogenates and in subcellular fractions served as a measure of radioinduced changes concerning total activity and intracellular localization of the enzymes. Activities of the following enzymes were measured: cytochrome c oxidase, catalase, aspartate aminotransferase, δ-aminolaevulate aminotransferase, alkaline phosphatase, acid phosphatase, phosphoglucomutase, glucose-6-phosphatase, adenosinetriphosphatase, porphobilinogen synthase, and ferrochelatase. (auth)(TSS)

7930 (NYO-3776-2) MICROBIAL DNA STRUCTURE AND RADIATION RESISTANCE. Technical Progress Report. (Vermont Univ., Burlington. Coll. of Medicine). Oct. 30, 1968. Contract AT(30-1)-3776. 7p. Dep. CFSTI.

Preliminary studies on the effects of γ radiation on the structure of DNA of bacteria are reported. The DNA of Micrococcus radiodurans (MRD), a microorganism extremely resistant to ionizing radiation was prepared and its purine and pyrimidine oligonucleotide population (derived from apyrimidinic and spurinic acids respectively) determined. Changes in the nature and size of the oligonucleotide clusters were determined after heavy γ irradiation of the DNA. (auth)(TSS)

7931 (ORO-2401-13) COMPARATIVE MATERNAL-FETAL TRANSFER OF ALKALINE-EARTH ELEMENTS. Schulert, A.; Glasser, S.; Stant, E.; Leecost, T. Jr.; Brill, A. B. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [nd]. Contract AT(40-1)-2401. 10p. (CONF-680452-1). Dep. CFSTI.

From 52nd Annual Meeting of the Federation of American Societies for Experimental Biology, Atlantic City, N. J.

The fetal uptake of alkaline-earth elements was investigated in rats following the injection of saline solutions containing mixtures of ^{131}Ba, ^{7}Be, ^{47}Ca, and ^{87}Sr into pregnant females on the 14th to 20th day of gestation. The animals were sacrificed at intervals of two hr and the content of the radioisotopes in fetal, placental, and maternal tissues was determined. Results demonstrated marked differences in the rate of maternal-fetal transfer of the radioisotopes and an effect of fetal age on the uptake of the various radioisotopes. (C.H.)

7932 (RLO-581-26) STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND THE FACTORS INFLUENCING THEM. Progress Report, August 1, 1967–July 31, 1968. (Oregon Univ., Portland. Div. of Experimental Medicine). Contract AT(54-1)-581. 79p. Dep. CFSTI.

ERYTHROCYTES—transformation by phytohemagglutinin, effects of erythropoietin on

HEMOGLOBIN—determination of peptide components in Portland 1, methods for

—dissociation of subunits of Kempsey, Rainier, Seattle, and Yakima, effects of pH on

—titration of tyrosyl groups from Kempsey, Rainier, Seattle, and Yakima, effects of oxygenation state on

—dissociation of subunits of H(β4)

—analysis of H(β4), sedimentation rate

PHYTOHEMAGGLUTININ—purification of, method for

—structure of, effects of ionic strength and pH on

—separation of subunits of, chromatographic, electrophoretic, and gel filtration methods for

—analysis for carbohydrates, use of gas-liquid chromatography for quantitative

—effects on lymphocyte transformation, effects of deuterium oxide on DNA and RNA synthesis following

—stability of mitogenicity of, in storage, effects of temperature and time on

—transformation of lymphocytes by, blood serum requirements for

—effects on transformation of lymphocytes, fluorescence analysis for mechanisms of

—effects on transformation of leukocytes from patients with atoxic telangiectasia

—effects on immune reactions in mice

PYRUVATE KINASE—analysis for molecular shape and size of subunits, biophysical

—purification for studies of molecular changes induced by activators and inhibitors, methods for (E.R.B.)

7933 (RLO-1783-18) THE ROLE OF NATURALLY OCCURRING QUINONES IN PHOTOSYNTHESIS. Yearly Progress Report, September 1, 1967–September 1, 1968. Bishop, Norman I. (Oregon State Univ., Corvallis. Dept. of Botany). Contract AT-(45-1)-1783. 10p. Dep. CFSTI.

It is found that uv radiation resulted in the destruction of plastoquinone; however, such destruction did not parallel the loss of photosynthetic activity. Of the many components of the chloroplast that were examined, only the quinone fraction was altered by uv radiation. It was noted that uv radiation caused a decrease in the variable yield fluorescence. A number of phospholipases and galactolipases were examined for their effect upon inactivation of chloroplast reactions and upon fluorescence for comparison with uv effects; the effects were identical. For studies on the role of plastoquinone in photosynthesis, a series of mutants of the alga, Scenedesmus obliquus, were isolated. Analysis of isolated pigments revealed no major change in these fractions nor in the various lipids of the chloroplasts. Electron microscopy revealed no structural alteration of the chloroplasts. However, when a sufficiently refined technique for the separation of the various quinone fractions of these mutants was developed such that plastoquinone could be separated from vitamin K and other substances it became apparent that of ten mutants examined eight had altered ratios of plastoquinone : chlorophyll. (H.L.W.)

7934 (UCRL-18066) BIOLOGY AND MEDICINE SEMIANNUAL REPORT, FALL 1967. Lawrence, John H. (ed.) (California Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 214p. Dep. CFSTI.

Separate abstracts were prepared on eight sections of this report. A list is included of 65 publications prepared during the period covered. (C.H.)

For abstracts of individual sections see: 7935, 7976, 7977, 8002, 8021–8023, and 8055.

7935 (UCRL-18066, pp 15-22) STUDIES ON THE BEHAVIOR OF ERYTHROPOIETIN-SENSITIVE CELLS IN THE MOUSE DURING RECOVERY FROM 200 R WHOLE-BODY IRRADIATION. Schooley, John C.; Hayes, Judith M.; Cantor, Linda N.; Havens, Virginia W. (California Univ., Berkeley. Lawrence Radiation Lab.).

Ten days after 200 R ^{60}Co γ whole-body irradiation the hematopoietic system of the polycythemic mouse contains three to four times as many cells available during a six-hr period for stimulation by erythropoietin into erythroid cells as does the unirradiated mouse. The irradiated polycythemic mouse does not, however, respond to fractionated doses of erythropoietin as does the unirradiated polycythemic mouse. Paradoxically, the irradiated mouse exhibits a greater response to a small dose of erythropoietin than an unirradiated mouse, although it shows a lower response to a large dose of erythropoietin. These results are discussed relative to a model of hemopoiesis that assumes that a population of cells derived from the stem cell rather than the stem cell itself is sensitive to the differentiative action of erythropoietin. (auth)

7936 MICROBIOLOGICAL METHOD OF SYNTHESIS OF ^{32}P-LABELLED ADENINE NUCLEOTIDES. Kozeltzev, V. L.; Debov, S. S.; Votrin, I. I.; Eremenko, V. V. (Setchenov Medical Inst., Moscow. Inst. of Biological and Medical Chemistry, Moscow). Vop. Med. Khim., 14: 549-52(Sept.-Oct. 1968). (In Russian).

A simple method for the preparation of ^{32}P-labeled adenine nucleotides is described. Cells of Brevibacterium ammoniagenes strain ATCC No. 6872 were grown in $Na_2H^{32}PO_4$-adenosine medium. The isolation of adenine nucleotides was carried out by chromatographic methods. (auth)

7937 GASTROINTESTINAL ABSORPTION OF ^{59}Fe AND TISSUE DISTRIBUTION OF RADIOIRON ABSORBED IN PROTEIN-DEFICIENT RATS AND THOSE REPLETED WITH DIETS CONTAINING CASEIN OF VARIOUS COMBINATIONS OR AMINO ACIDS: COMPARATIVE EFFECTS OF THESE DIETS ON ERYTHROPOIESIS. Aschkenasy, A. (Centre National de la Recherche Scientifique, Montrouge, France). Arch. Sci. Physiol., 21: 127-51(1967). (In French).

The absorption of ^{59}Fe, its tissue distributions and the erythropoietic utilization of the absorbed ^{59}Fe, as affected by dietary amino acids were studied. Male Sherman rats weighing about 220 g were used, five of which formed the control group receiving a diet of 18% casein and 59 of which were on a protein-deficient diet for seven wks. Then the deficient rats were subdivided and put on a variety of protein-containing diets. After four days each rat received 0.5 to 0.8 μCi of ^{59}Fe ($^{59}FeCl_3$) in acid solution through a stomach tube. Intestinal absorption and erythropoietic utilization of ^{59}Fe were found to be less than normal in protein-deficient rats. However, when a restorative diet of 18% casein was given, ^{59}Fe absorption increased. When the casein was replaced by 19 amino acids, absorption of radioiron increased even more. When the repleting diets were lacking in only one essential amino acid, absorption was inhibited, in some cases more than during protein deficiency. Fecal excretion of ^{59}Fe was greater than normal with all the diets. Erythropoietic utilization of ^{59}Fe was reduced according to the particular amino acid withheld. Digestive tract uptake of ^{59}Fe diminished after prolonged deficiency, as did the uptake for muscle and kidney. However, the lung uptake of ^{59}Fe was higher than normal. It was concluded that anorexia caused by the initial starvation period accounted for some of the inhibition in erythropoiesis and absorption of ^{59}Fe. (BBB)

7938 HISTONES: PREPARATION, FRACTIONATION, AND METABOLIC EFFECTS OF X-IRRADIATION. Driedger, Albert Abram. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1967. 298p.

Thesis.

Histones are defined operationally as the basic, acid-extractable proteins of isolated nuclei or deoxyribonucleoprotein (DNP). Methods were developed for the differential acid extraction of histones from isolated nuclei and for their electrophoretic fractionation in polyacrylamide gels. Electrophoresis in this medium was more reproducible than in starch gels. A method was also developed for the acetylation in dioxane under mild conditions of more than 95% of the ninhydrin-reacting groups of histone: the acetylated product has altered characteristics that should prove useful in further studies on the fractionation of histones. A multiple extraction method with progressive increases in the strength of acid provided a helpful preliminary fractionation of the histones. Extracts of histones from the isolated nuclei of various rat tissues showed many differences between the histones from tissue to tissue. The effect of 1000 R of x rays on the incorporation of ^3H-thymidine and ^{14}C-lysine into DNA and histones respectively of rat liver, spleen, and thymus was studied throughout the subsequent 24 hours. Some of the fractions which were the most mobile on electrophoresis were lost in the early post-irradiation period. In all three tissues and at all times the synthesis of DNA was suppressed more by the irradiation than was histone synthesis. The effect on liver DNA synthesis was quite different from that reported in the literature. In all tissues histone synthesis continued at an altered rate after DNA synthesis had completely halted. On fractionation of the histones some fractions were inhibited by irradiation to about the same extent as was DNA synthesis. On the basis of the tracer study a model of the metabolic relationship existing between DNA and histone was advanced. Histone metabolism may be considered as occurring in two compartments: one compartment is new histone that is synthesized in step with DNA and the other is turnover histone, the synthesis of which maintains the histone pool of the cell at the required level. The results suggest that the new histone consists predominantly of small molecular weight histones. (Disser. Abstr.)

7939 EFFECT OF UV RADIATIONS ON AMINO ACIDS. PART I. PRELIMINARY STUDIES OF UV RADIATION INDUCED CHANGES IN AQUEOUS SOLUTION OF METHIONINE. Pathak, H. D.; Pant, H. C.; Mahendra, Pal (Government Coll., Naini Tal, India). Indian J. Biochem., 5: No. 2, 65-8(June 1968).

Irradiation of sterilized aqueous solution of methionine with uv light (250 W) for 20 hr from a distance of 50 cm gave nine chromatographically separable and ninhydrin reactive products. Four of these products appeared even when methionine was irradiated for a short period (five hr). Of these some products exhibited fluorescence in uv light. The yield of products was more when ammonia was present in the irradiation mixture. While colloidal molybdenum oxide favored the degradation of methionine, colloidal iron oxide inhibited it. Benzophenone, acenaphthene, and ammonium molybdate accelerated the photolysis of methionine. But in the presence of benzophenone and acenaphthene, a new compound was detected on the chromatogram. (auth)

7940 ASSAY OF ^{32}P IN BIOLOGICAL MATERIAL BY USING A CHERENKOV COUNTER. Haasbroek, F. J.; Lotz, E. v. d. S. (Fruit and Food Technol. Research Inst., Stellenbosch, S. Africa). S. Afr. J. Agr. Sci., 10: 285-8(1967).

The determination of ^{32}P in wet-ashed peach leaves or wheat tops by using Cherenkov radiation detectors in place of Geiger-Müller tubes was examined. The results were regarded as justifying further investigation of the method. (Anal. Abstr.)

7941 PROCEDURE FOR DETERMINATION OF RADIOACTIVE METABOLITES FROM TRITIATED OXYTOCIN IN TISSUES. Sjoeholm, I.; Ryrfeldt, A. (Kungliga Farmaceutiska Institutet, Stockholm). Acta Pharm. Suec., 4: 77-80(1967).

The tissue was placed in a weighed glass phial cooled in solid CO_2-ethanol. The phial was weighed again, 2M acetic acid (1 ml per 0.3 g of tissue) and carrier peptide soln. (200 to 500 μl) were added and, after thawing, the mixture was homogenized. The 20% aq. trichloroacetic acid was added to the suspension to give a concn. of 5%. After centrifuging and washing the ppt., the trichloroacetic acid was removed from the clear soln. by shaking with ethyl ether, and the soln. was dried in vacuo over P_2O_5 and KOH. The residue was dissolved in 0.1M acetic acid and subjected to TLC on a layer (0.25 to 1 mm thick) of cellulose powder MN 300-Silica gel G (2:1) with butanol-dioxan-2N aq. NH_3 (4:1:5) as developing solvent. Ninhydrin was used as spray reagent, and the relevant areas were extracted with 1 to 2 ml of M-methanolic Hyamine 10-X. Scintillator soln. [1,4-bis-(5-phenyloxazol-2-yl) benzene (0.3 g) plus 2,5-diphenyloxazole (5 g) in 1 litre of toluene] (10 ml) was then added to each extract, and the ^3H was determined. The yield was 99.5% (standard deviation ±1.3%). (Anal. Abstr.)

7942 KINETICS OF PRODUCTION OF ANTIBODY-FORMING CELLS IN THE SPLEENS OF MICE AFTER PRIMARY IMMUNIZATION WITH SHEEP ERYTHROCYTES. Shearer, Gene Martin. Knoxville, Tenn., Univ. of Tennessee, 1967. 153p.

Thesis.

The kinetics of production of antibody-forming cells were studied in the spleens of the mice immunized with sheep erythrocytes, and in the spleens of x irradiated mice grafted with lymphoid cells. In the latter, known numbers of unprimed spleen or lymph node cells were mixed with sheep erythrocytes and injected into irradiated syngeneic recipients. Donor-derived antibody-forming cells were enumerated in the recipient spleens. Cells producing hemolysins of the direct and indirect varieties and cells producing hemagglutins were detected. The purpose of the study was to see how the kinetics of appearance following antigen administration differed for the 3 types of immunocytes and whether the differences could be explained on the assumption that separate lines of antigen-sensitive precursor cells generate different types of antibody-

forming cells. Furthermore, the primary immune response of the mouse to sheep erythrocytes was modified by pre-treating lymphoid cell donors with phytohemagglutinin. For the same purpose, mice carrying a mutant allele at the W locus, known to affect the hematopoietic system, and germfree mice were studied with respect to their primary immune response. Results showed that the primary cellular immune response of intact germfree mice and or irradiated germfree mice is indistinguishable from the response of comparable conventional mice; exposure of lymphoid cells to phytohemagglutinin for 3 days in vivo does not alter the frequency of antigen-sensitive cells in lymph nodes, but reduces to about one-half the potential of antigen-sensitive cells to produce antibody-forming cells; the spleens of genetically anemic mice, homozygous for the W^v allele, contain about one-half the number of antigen-sensitive cells contained in the spleens of non-anemic litter-mates; antigen-sensitive cells generating direct plaque-forming cells (19S hemolysins), indirect plaque-forming cells (7S hemolysins), and cluster-forming cells (hemagglutinins) are distinguishable from each other because their frequencies in mouse spleen cells are widely different. Their relative frequencies are, respectively, 1 in 10^6, 1 in 7×10^6, and 1 in 19×10^6. It follows that antigen-sensitive cells, i.e., cells interacting with antigen, are already differentiated with respect to the type of antibody-forming cells which they can generate. (Diss. Abstr.)

7943 A STUDY ON HEMOLYSIS CAUSED BY ^{60}Co γ IRRADIATION. A STUDY ON HEMOLYSIS OF VARIOUS MAMMALIAN BLOOD IN THE HYPOTONIC SOLUTION AND CHEMICAL INVESTIGATION ON THE HEMOLYSIS OF HORSE RED CELLS. Sunada, Shigeo (Nihon Univ., Japan). Nichidai Igaku Zasshi, 27: 785-96 (July 1968). (In Japanese).

The hemolysis of mammalian red cells irradiated by a large dose of 3.4×10^4R ^{60}Co γ rays in vitro in 0.6% NaCl solution, and the chemical change in the phospholipid fraction of irradiated horse red cells were studied. The results were as follows: The blood of various mammals always hemolyzed in 0.6% NaCl solution. However, the hemolysis rate was expressed in turn as follows: sheep > goat > horse > ox > pig > rabbit > dog > man. The red cells of every species irradiated were hemolyzed in 0.6% NaCl solution. A large amount of lecithin was found in the horse red cell. The lecithin fraction was seriously affected by ^{60}Co γ irradiation with doses of 1.0×10^4 to 6.0×10^4 R. The substances expressed by C'_{18} and C''_{18} of the lecithin were damaged by the irradiation. (NSA of Japan)

7944 EFFECT OF BADE ON THE ELIMINATION OF RADIOSTRONTIUM FROM THE ORGANISM. Slat, B.; Vojvodic, S.; Maljkovic, T.; Kostial, K. (Inst. of Medical Research, Zagreb). Arh. Hig. Rada Toksikol., 19: 40-5(1968). (In French).

The effect of Na_2 (Sr BADE) BADE = 2,2-bis[(dicarboxymethyl) amino] diethyl ether on the elimination of ^{85}Sr from rats aged 2 to 5 mos was determined. The radioactive isotope and the chelating agent were administered intraperitoneally. The animals were sacrificed 72 hrs after injection of ^{85}Sr. Na_2 (Sr BADE) in a dose of 1.66 mmole/kg reduced the retention of ^{85}Sr in the skeleton by approximately 40%. Its effect in increasing elimination and reducing retention was independent of the age of the rats. The same effect was obtained by administering an equimolar amount of $SrCl_2$. An effect of the same order resulted on administration of Na_2 (Sr CPDTA) (CPDTA = cyclopentanediamine-(1,2)-tetraacetic acid), but Na_2 (Sr BADE) is less toxic than Na_2 (Sr CPDTA) and can be administered in higher doses. (JPRS)

7945 THE EFFECT OF CHANGES IN POSITION ON THE CLEARANCE OF RADIOACTIVE SODIUM FROM THE HEAD OF THE FEMUR OF IMMATURE DOGS. Wisham, Lawrence H.; Katz, Jacob F.; Dworecka, Frances F. (Mt. Sinai Hospital, New York). Amer. J. Orthop., 8: 132-5 (Sept.-Oct. 1966).

Radiosodium studies were conducted in immature dogs with open epiphyses, confirmed by x rays. A hole was drilled up the femoral neck into the head, and a special syringe was screwed into this drill hole to the same depth. Before the syringe was placed in the head, it was loaded with an isotonic sterile solution of radiosodium as the chloride, containing a concentration of 2 to 3 μCi per 0.1 ml of solution. The radiosodium was then injected, and a collimated scintillation counter was placed over the injected hip and the geometrical relation of the hip and counter maintained throughout the experiment. The radioactivity present under the counter was continuously recorded. After 10 min the hip of the animal was manually abducted and externally rotated and maintained in this position for periods ranging from 4 to 12 min, during which time the readioactivity present was recorded. The hip was then replaced in the original position and again the radioactivity present was determined for 10 or more min. The radiosodium clearance constant at rest ranged from 0.0139 to 0.0693 min^{-1}; or if expressed in the percentage of cleared radiosodium after 10 min, the range was 12 to 44%. The standard deviation for the resting clearance rates was 0.0162 min^{-1}. When the hip was manually abducted and externally rotated at the extreme of the normal range of motion, the clearance rate fell to 0 in 17 of the 20 dogs. This represented a highly significant drop in the rate of clearance. (BBB)

7946 URINARY PYRIMIDINES AFTER X IRRADIATION. Guri, Charles D.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). Clin. Chem., 14: 383-90 (May 1968).

Some pyrimidine compounds were elevated in urine after exposure to ionizing radiation, presumably representing either an alteration in the incorporation of these compounds into nucleic acids (DNA) or the catabolic products of radioinduced DNA degradation. Urinary deoxycytidine (CdR) and other pyrimidines were assayed in urine and plasma of female Sprague-Dawley rats after whole-body x irradiation. Combined column and paper chromatography and colorimetric determination of the isolated CdR revealed significant elevations in its excretion during the first 24 hr after irradiation. Increased concentration of CdR in the plasma was also observed within four hr after irradiation. Anion- and cation-exchange chromatography after irradiation also revealed an increase in several other pyrimidines, including derivatives of the bases cytosine, thymine, and uracil. While the data were suggestive of a radioinduced generalized pyrimidinuria, urinary CdR and thymidine demonstrated remarkable elevation and were predominantly responsible for this phenomenon. (BBB)

7947 ISOAMYLASES IN ORGANS AND BODY FLUIDS OF RATS AND RAT FETUSES: CHANGES FOLLOWING TOTAL-BODY IRRADIATION. Goetze, T. Acta Biol. Med. Ger., 19: 519-28 (1967). (In German).

Amylase activity was demonstrated in 16-day-old rat fetuses in the pancreas, amniotic fluid, serum, liver, and placenta. Rats had two isoamylases, and a third activity zone was seen in some instances. Isoamylases in fetal rat serum had a distribution pattern differing from that of the maternal serum. The pattern of maternal serum was similar to that of the salivary glands; fetal serum showed a pronounced fraction in the γ-globulin region and resembled in its distribution pattern that of pancreatic amylase. The amniotic fluid also had the same amylase isozyme pattern as pancreas. The placental labyrinth and the connecting zone contained two isoamylases, as in maternal and fetal liver. After whole-body x irradiation of pregnant rats, the isoamylase activities of different organs increased. In the serum of adult animals the distribution pattern varied. (BBB)

7948 THE MOVEMENT OF INHALED MATERIAL FROM THE RESPIRATORY TRACT TO BLOOD: AN ANALOGUE INVESTIGATION OF THE NEW LUNG MODEL. Dyson, E. D.; Beach, S. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 15: 385-97 (Nov. 1968).

The proposed new lung model of the ICRP Task Group (Health Phys., 12: 173(1966)) was simulated on an analogue computer, to investigate transfers and rates of transfer between respiratory tract and blood. Results are given in graphical form. Dusts of 4.0 and 0.5 μ AMAD (activity median aerodynamic diameter) were studied, using parameter values taken from the values suggested in the Task Group report. Some parameter values were altered to investigate the effect of the pulmonary lymph glands on the model. Peaks in the transfer rate to blood, at around 200 days after inhalation, were noted when transfer through these glands was increased. About a third of the total transfer to blood of 4.0 μ AMAD insoluble dust takes place in the first day after inhalation, from the naso-pharynx and trachea and bronchi. This transfer is particle-size dependent, and is one-fourteenth for 0.5 μ AMAD dust. Therapeutic measures would be required almost immediately to be effective against this transfer. The fraction of insoluble plutonium absorbed from the naso-pharynx is about 300 times greater than that from the gut. Soluble dusts may be considered to be transferred totally and immediately to blood. For moderately soluble dusts absorption from the GI tract to blood, of an unspecified degree, requires consideration. (auth) (UK)

7949 COMPARATIVE METABOLISM OF RADIONUCLIDES IN MAMMALS. IV. RETENTION OF ^{110m}Ag IN THE MOUSE, RAT, MONKEY, AND DOG. Furchner, J. E.; Richmond, C. R.; Drake, G. A. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 15: 505-14(Dec. 1968).

Radiosilver (^{110m}Ag) was administered to mice, rats, monkeys, and dogs by oral and intravenous routes and also intraperitoneally to mice and rats. Retention as a function of time was determined by periodic assay in 4π liquid scintillation detectors. The data were adequately described by exponential expressions. Ninety per cent or more of oral doses were not absorbed. In all routes of administration more than 90% of the silver excreted was in the feces. A parabolic relation between body weights and estimated equilibrium levels in small animals was extrapolated to man.

From such estimates an MPC_W value of 1.8 nCi/cm^3 (when the whole body is the critical organ) was derived. The ICRP value of 0.3 nCi/cm^3 for the lower large intestine is still the limiting value. (INIS) (UK)

7950 BIOLOGICAL RESPONSE TO SMALL DISCRETE HIGHLY RADIOACTIVE SOURCES. I. OBSERVATIONS ON GASTROINTESTINAL TRANSIT, HISTOLOGICAL CHANGE, AND TISSUE DEPOSITION IN BEAGLES FED ONE-HALF CURIE $^{238}PuO_2$ FOR 6 MONTHS. Richmond, C. R.; London, J. E.; Wilson, J. S.; Langham, J. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 15: 487-92 (Dec. 1968).

Biological response to high specific activity particulate nuclear fuels being considered for heat sources in thermoelectric generators may ultimately influence use of such systems in space programs; conventional concepts of radiation dose contribute little to hazard evaluations because of huge energy depositions in very small tissue volumes. Studies have established that nuclear fuel particles are not preferentially retained in the G.I. tract of man because of small size or high density. The effects of high surface doses (~10^8 and ~10^3 RAD/hr for alpha and x rays, respectively) on holdup and histological changes within the G.I. tract are reported. Forty $^{238}PuO_2$ particles were fed weekly for 25 weeks to beagles from an electrically driven carrousel. The average particle (189 μ diameter) contained 0.55 mCi of ^{238}Pu. Whole-body counting was used to determine the presence or absence of particles in the dogs following each weekend nonfeeding period; no evidence for prolonged holdup was found. Although no gross histological changes were observed at sacrifice, some histological changes of unknown significance were detected in the lamina propria. No changes were seen in the epithelium. Deposition in liver, mesenteric lymph node, and spleen was 10^{-10} to 10^{-8} of the fed activity. (UK) (INIS)

7951 SHORT CAESIUM HALF-TIMES IN PATIENTS WITH MUSCULAR DYSTROPHY. Lloyd, R. D. (Univ. of Utah, Salt Lake City). Nature (London), 220: 1029-31 (Dec. 7, 1968).

A comparison was made between the half-times in persons with muscular dystrophy and values for normal subjects, employing ^{137}Cs. It was found that, in general, the greater the disability the shorter the Cs half-time. Results are tabulated. (UK)

7952 FURTHER STUDIES OF IRRADIATED NERVE HETEROGRAFTS IN ANIMALS WITH IMURAN IMMUNOSUPPRESSION. Marmor, Leonard; Hirasawa, Yasusuke (Univ. of California, Los Angeles). J. Trauma, 8: 32-46 (Jan. 1968).

In studies with dogs, guinea pigs, and rats, irradiation of nerve heterografts with 2,000,000 rep by a Van De Graaf generator, combined with administration of Imuran appeared to be effective at the acute inflammatory stage, thus leading to a decreased amount of fibroblast invasion. The resulting decrease of fibrosis allowed axonal regeneration to pass the distal barrier of the grafts. (TSS)

7953 RADIOISOTOPES IN THE HUMAN BODY: PHYSICAL AND BIOLOGICAL ASPECTS. Spiers, F. W. Monograph Series on Radiation Biology. New York, Academic Press, Inc., 1968. 359p. $15.00. (TID-24583).

A unified discussion of the manner in which radioisotopes are deposited in the human body and of the methods by which the relevant dosimetry can be determined is presented. The book is intended for biologists, physicists, and health physicists who are concerned with the uptake of radioisotopes by human beings. Emphasis is placed on biological aspects of the deposition of radioisotopes in the body and the relation of these aspects to the determination of the dose to body tissues. A description of the properties of radioisotopes is included, followed by chapters on isotope metabolism, dosimetry in soft tissues, the structure of bone, and dosimetry in bone. Other chapters are included on dosimetry of alpha and beta emitters in bone, the concept of relative biological effectiveness, dose to body tissues from natural and man-made sources, and determination of maximum permissible levels of internally deposited radioisotopes. (H.L.W.)

7954 EFFECTS OF X RADIATION ON DNA SYNTHESIS IN HOMOZYGOUS STRAINS OF YEAST OF DIFFERENT DEGREES OF PLOIDY. Jannsen, Sigrid; Lochmann, Ernst-Randolf; Laskowski, Wolfgang (Freie Univ., Berlin). Z. Naturforsch., 23b: 1500-7 (Nov. 1968). (In German).

Since Saccharomyces cells have only a very small uptake of thymine or thymidine, the uptake of labeled samples of these compounds cannot be used to measure the rate of DNA synthesis. Instead two other methods were used for both x-irradiated and unirradiated cells of a series of homozygous isogenic Saccharomyces strains of different ploidy: yeast cells were incubated with adenine-8-^{14}C, the labeled DNA was isolated and completely separated from RNA, and the specific radioactivity of the DNA was determined. The reduction of the specific radioactivity after irradiation as a proportion of the specific radioactivity of unirradiated control cells gave the x-ray induced inhibition in the rate of DNA synthesis. The uptake of thymine-2-^{14}C-5'-monophosphate, which is the only thymine compound incorporated into the DNA of Saccharomyces in any appreciable amount, was measured after various incubation times for irradiated and control cells. The results of the two methods are compared and the possibilities for their application are discussed. The dose effect curve for the rate of DNA synthesis after x-irradiation shows two phases: a steep slope at low doses with a shallow slope at high doses. For low doses the proportional decrease with x-irradiation in the rate of DNA synthesis is of the same order of magnitude as that of the colony forming ability, and is considerably greater than that of other metabolic processes such as protein and RNA synthesis, respiration or fermentation. The dependence of this proportional decrease on degree of ploidy is also similar to that dependence shown by colony forming ability and is again different from the dependence shown by RNA or protein synthesis. The reduction in DNA synthesis is greater the greater the time of incubation after irradiation. (auth)

7955 BASE COMPLEMENTARITY BETWEEN RAPIDLY LABELED RNA IN ESCHERICHIA COLI B INFECTED WITH ULTRAVIOLET-IRRADIATED T_2 PHAGES AND T_2-DNA. Yamada, Yoshihiko; Nozu, Keiichi (Osaka Univ.). Biochim. Biophys. Acta, 169: 67-79 (Nov. 20, 1968).

The amounts of hybrid between the rapidly labeled RNA formed in Escherichia coli B after infection with ultraviolet-irradiated T_2 phage and the denatured T_2-DNA were less than those between the RNA specific for the non-irradiated T_2 phage and the T_2-DNA. The amount of hybrid in the former couple decreased with the increase of ultraviolet dose on T_2 phages. The results of saturation and competition experiments on hybrid formation made it clear that the base sequence of the rapidly labeled RNA in the bacteria infected with ultraviolet-irradiated T_2 phages was different from that of normal T_2 messenger RNA. The reduced formation of hybrid between the T_2-DNA and the UV-T_2-RNA was caused by a decreased base complementarity to the T_2-DNA in large molecules of UV-T_2-RNA. (auth)

7956 EFFECT OF γ-RADIATION ON AQUEOUS SOLUTIONS OF DNA'S OF DIFFERENT BASE COMPOSITION. Rafi, A.; Weiss, J. J.; Wheeler, C. M. (Univ. of Newcastle upon Tyne, Eng.). Biochim. Biophys. Acta, 169: 230-40 (Nov. 20, 1968).

The effects of γ-irradiation on seven DNA's of different origin, with base composition varying from 29 to 69 mole per cent of adenine-thymine, were studied. The ultraviolet absorption and absorbance as well as the melting curves were measured in order to investigate the following effects: loss of double-helical structure; destruction of purine and pyrimidine bases; differential denaturation i.e., the relative radiation sensitivity of the constituent A–T and G–C hydrogen-bonded base pairs. Among other features the results indicate that the inherent radiation sensitivity decreases with decrease in A–T content of the native DNA. (auth)

7957 BONE MARROW AS SOURCE OF CELLS IN REACTIONS OF CELLULAR HYPERSENSITIVITY. II. IDENTIFICATION OF ALLOGENEIC OR HYBRID CELLS BY IMMUNOFLUORESCENCE IN PASSIVELY TRANSFERRED TUBERCULIN REACTIONS. Lubaroff, David M.; Waksman, Byron H. (Yale Univ., New Haven). J. Exp. Med., 128: 1437-47 (Dec. 1, 1968).

The precise origin of cells infiltrating tuberculin skin reactions was studied with the technique of immunofluorescence. Thymectomized, irradiated Lewis rats were restored with bone marrow from allogeneic or F_1 donors. They were passively sensitized to tuberculin by a subsequent transfer of Lewis lymph node cells and were given intradermal skin tests with tuberculoprotein. In 24 hr reactions the majority of cells were shown to be derived from the infused marrow. These results were the same regardless whether the lymphocyte transfer was performed on the day of irradiation and marrow injection or 7 days later. The cells in the tuberculin reactions, marrow, spleen, and lymph nodes not derived from the bone marrow were found to originate in the transferred lymph node cells. The relative percentages of marrow-derived and lymph node-derived cells in the tuberculin reactions remained the same during the 9 to 24 hr period following skin test. (auth)

7958 THYMUS AND RECOVERY OF THE SHEEP ERYTHROCYTE RESPONSE IN IRRADIATED MICE. Aisenberg, Alan C.; Davis, Caroline (Harvard Univ., Boston). J. Exp. Med., 128: 1327-38 (Dec. 1, 1968).

The role of the thymus in the recovery of the sheep erythrocyte response after lethal irradiation was studied in adult CBA mice with the hemolytic plaque technique of Jerne. This immunological parameter is markedly thymus-dependent. Ten wk after irradiation and after antigenic challenge the thymectomized animal has

only one-twentieth to one-fortieth the number of plaque-forming cells as does the irradiated animal with intact thymus. The thymus continues to function into the 7th and 8th month of life in this strain. Unlike the drug-tolerant animal, the incompetent irradiated thymectomized mouse retains base line plaques (plaques without antigenic stimulation). Thymectomy 18 days after irradiation is as effective as prior thymectomy in preventing recovery of the sheep cell response. Thymectomized animals receiving grafts of isogenic neonatal thymus (placed beneath the kidney capsule) 1 day, 1 wk, or 2 wk after irradiation are somewhat more responsive at 10 wk than intact animals. Grafts in place for 1 or 2 wk after irradiation and then removed result in one-fifth the recovery of grafts in place the entire time, while only slight restoration is obtained from grafts in place for the final 3 wk of the experiment. The results indicate that the thymus is not required for the 18 days after irradiation, that a period of at least 3 wk residence is required for complete restoration, and that the thymus itself is somewhat radiation-sensitive. Allogeneic thymus grafts failed to restore the hemolysin response of irradiated thymectomized animals. (auth)

7959 EFFECTS OF RADIATION ON DIRECT AND DEVELOPED SPLEEN HEMOLYSIN PLAQUE-FORMING CELLS OF MICE. Uyeki, Edwin M.; Klassen, Robert S. (Univ. of Kansas, Kansas City). J. Immunol., 101: 973-8(Nov. 1968).

The effects of 500 R whole body γ radiation on direct and developed hemolysin plaque-forming cells in spleen tissue and on serum hemolysin levels of LAF_1 mice were investigated. The major findings were: Fourteen-day assay involving a single antigen injection: When radiation was administered two days before or three days after antigen, spleen hemolysin plaque-forming cell production was markedly lowered when compared with spleen hemolysin plaque-forming cells of non-radiated animals. With this injection scheme, the principal cell type was the developed hemolysin plaque-forming cell. Spleen cellularity of radiated animals was significantly below that of non-radiated control animals. Fourteen-day assay involving two antigen injections: A second antigen injection six days after radiation stimulated antibody-forming cell production so that the total spleen hemolysin plaque-forming cells of the once-radiated animals were comparable to non-radiated control animals. Radiation, administered after the second antigen, markedly inhibited hemolysin plaque-forming cell production as well as spleen cellularity. Twenty-eight-day observation period involving multiple antigen injections: The effects of a single dose of 500 R administered to LAF_1 mice 3 days after an initial antigen injection and given a total of two, three and four antigen injections at weekly intervals and analyzed at 14, 21 and 28 days, respectively, showed no difference from nonradiated animals in their ability to respond to antigenic stimulation. In these animals, spleen cellularity was consistently lower than in nonradiated animals. (auth)

7960 FURTHER CHARACTERIZATION OF THE LYMPHOID CELL TRANSFER SYSTEM FOR THE STUDY OF ANTIGEN-SENSITIVE PROGENITOR CELLS. Bosma, M. J.; Perkins, E. H.; Makinodan, T. (Inst. for Cancer Research, Philadelphia. Oak Ridge National Lab., Tenn.). J. Immunol., 101: 963-72(Nov. 1968).

Further characterization of a lymphoid cell transfer system, a system in which heavily x-rayed syngeneic mice served as passive recipients for the antibody expression of transferred spleen cells, revealed the following: Most of the serologically detectable hemagglutinins and hemolysins released into the blood during the 1st week after cell transfer were synthesized by the repopulated spleen. Only a small fraction of the transferred immunocompetent cells colonized initially in the spleen. This fraction was estimated to be about 10% on the basis of the double spleen cell transfer method. This serologic appraisal was in striking concordance with the estimate based on the number of hemolysin plaque-forming cells in the repopulated spleen. The accuracy of these estimates was dependent upon spleen cell dose and, in the case of non-primed spleen cells, also on the time when the repopulated spleen was removed from the primary recipient. The effect of the colonizing density on the ratio of the maximum number of hemolysin plaque-forming cells in the spleen to the unit number of spleen cells transferred was as follows: the ratio was large and constant at optimal spleen cell doses, but relatively small and variable at limiting spleen cell doses. (auth)

7961 RECOVERY OF DELAYED-TYPE HYPERSENSITIVITY IN MICE FOLLOWING SUPPRESSIVE DOSES OF X-RADIATION. Volkman, A.; Collins, F. M. (Trudeau Inst. Inc., Saranac Lake, N. Y.). J. Immunol., 101: 846-59(Nov. 1968).

A study was made of the effects of sub-lethal whole body x radiation on an established state of delayed hypersensitivity induced by the intravenous infection of mice with Mycobacterium bovis (BCG) or Salmonella gallinarum. The level of delayed sensitivity was determined by measuring the foot-thickness 24 hr after the injection of a suitable eliciting antigen into the footpad. In appropriately sensitized mice the delayed reactivity to both PPD and the Salmonella antigen was largely suppressed by 400 rad of whole body x-radiation. No recovery of reactivity was detected in the 8 days following irradiation of tuberculin sensitive mice. On the other hand, in mice sensitized to S. gallinarum there was a gradual recovery in footpad reactivity. X-radiation resulted in an abrupt decline in the absolute numbers of circulating lymphocytes, monocytes but not granulocytes. Low white cell counts were sustained throughout the remainder of the experiment. Concurrent autoradiographic labeling studies showed a fall in the labeling index of mononuclear exudate cells at the reaction site coincident with minimal footpad reactivity. The subsequent return of a normal labeling index in the cells of the infiltrate was associated with the recovery of a significant degree of specific footpad reactivity. These results were interpreted to favor the concept that delayed hypersensitivity is mediated by two cell populations. The first is relatively radioresistant and endowed with the specific sensitivity necessary to initiate a delayed reaction. The second, which is necessary for its ultimate expression, is derived from radiosensitive precursors that are capable of rapid regeneration. (auth)

7962 DEUTERIUM ISOTOPE EFFECTS IN THE FERMENTATION OF HEXOSES TO ETHANOL BY SACCHAROMYCES CEREVISIAE. I. HYDROGEN EXCHANGE IN THE GLYCOLYTIC PATHWAY. Saur, Wolfgang K.; Crespi, Henry L.; Halevi, E. A.; Katz, Joseph J. (Argonne National Lab., Ill.). Biochemistry, 7: 3529-36(Oct. 1968).

Deuterium isotope effects were used to study the fermentation of hexoses to ethanol. Ordinary D-glucose and D-mannose were fermented by Saccharomyces cerevisiae in D_2O and fully deuterated mannose and glucose-6-d_2 were fermented in H_2O. The product ethanol has the general composition $CH_xD_{3-x}CH_yD_{2-y}OH$, and a quantitative analysis of the mixture of partially deuterated ethanols can be accomplished by proton magnetic resonance and mass spectroscopy. From the isotopic composition of the ethanols, we conclude the following. Exchange with the medium of the methylene group of the product ethanol occurs at the triose phosphate level during the sequence triose phosphate isomerase–aldolase–glyceraldehyde diphosphate dehydrogenase. These three steps are listed in probable order of decreasing rate, the final step occurring under conditions in which the hydrolysis of the acyl-enzyme complex by inorganic phosphate is rate determining. The incorporation of H or D from the medium into the methyl group in the ethanol requires the presence of both phosphoglucose and phosphomannose isomerase during fermentation of either mannose or glucose. It also requires further exchange by pyruvate kinase. The alternative to pyruvate exchange, C_1-C_6 interconversion by adolase-triose phosphate isomerase, is much more difficult to reconcile with the data, although it cannot be rigorously excluded at this point. (auth)

7963 POSSIBILITY OF THE REPAIR OF DOUBLE-STRAND SCISSIONS IN MICROCOCCUS RADIODURANS DNA CAUSED BY GAMMA-RAYS. Kitayama, Shigeru; Matsuyama, Akira (Inst. of Physical and Chemical Research, Tokyo). Biochem. Biophys. Res. Commun., 33: 418-22(Nov. 8, 1968).

After labeling with ^3H-thymidine, cells were harvested at the logarithmic phase of growth, and γ-irradiated. During post-irradiation incubation, cells were harvested at 60 min intervals and transformed into protoplasts by incubation with lysozyme. The molecular weight of DNA was estimated on the basis of its observed distance of sedimentation. Irradiated cells and controls were subjected to sedimentation analysis using neutral sucrose gradients. The sedimentation rate was decreased by irradiation, but increasing the time of post-irradiation incubation restored the sedimentation rate. When incubation was carried out in the presence of chloramphenicol there was no recovery of the sedimentation rate. The reduction of sedimentation rates on neutral sucrose gradients can be explained as the result of simultaneous breakages or of two lesions separated by very few nucleotides in both strands of DNA caused by radiation. Repair of single- and double-strand scissions in irradiated bacterial DNA is discussed in terms of energy-loss events. (H.L.W.)

7964 INCORPORATION OF TRITIUM INTO IRRADIATED NUCLEOTIDES. Kunieda, T. (National Inst. of Health, Bethesda, Md.); Grossman, L.; Witkop, B. Biochem. Biophys. Res. Commun., 33: 453-6(Nov. 8, 1968).

Irradiated samples of polyuridylic acid and DNA from Escherichia coli were hydrogenolyzed by $NaBT_4$ in 50% dioxan. The irradiated samples of polyU attained constant activity after three acid treatments followed by evaporation. When radioactivity was plotted versus concentration of uracil dimers, an essentially linear

relationship resulted. When the irradiated samples of DNA were plotted in a similar fashion, the introduction of tritium correlated with the time of irradiation. Results suggested the hydrogenolysis of irradiated nucleotides and nucleic acids by sodium borotritide as a feasible method for marking and modifying the areas of photodimerization with tritium. (H.L.W.)

7965 TRITIUM EXCRETION OF NORMOTENSIVE AND HYPERTENSIVE SUBJECTS AFTER ADMINISTRATION OF TRITIATED NOREPINEPHRINE. Gitlow, S. E.; Mendlowitz, M.; Bertani, L. M.; Wilk, E. K.; Glabman, S. (Mt. Sinai Hospital, New York). J. Lab. Clin. Med., 73: 129-34(Jan. 1969).

The excretion of a standard test dose of ^{3}H-NE was greater in patients with essential hypertension than in normal subjects. This abnormality in catecholamine metabolism was not related to renal function but appeared to reflect a defect in internal handling of ^{3}H-NE by the patient with essential hypertension. The test procedure may be of diagnostic usefulness for the detection of essential hypertension. (auth)

7966 NEW RAPID RADIOIMMUNOASSAY FOR HCG (LH,ICSH) IN PLASMA USING DIOXAN. Thomas, K.; Ferin, J. (Univ. of Louvain, Belg.). J. Clin. Endocrinol. Metab., 28: 1667-70(Nov. 1968).

A highly purified preparation of the hormone HCG was used for the production of antisera, preparation of iodine-131-labeled hormone, and determination of standard curves. The organic solvent dioxan was used to separate free hormone from specific antigen-antibody complexes. Iodine-131-labeled HCG was diluted in phosphate buffer containing 1% bovine serum albumin. Graphs are presented to show solubility of HCG-^{131}I and HCG-^{131}I-antibody complex at various dioxan concentrations; standard assay curves of HCG with and without horse serum; and comparison between plasma HCG levels found by the double antibody technique and dioxan technique. (H.L.W.)

7967 MEASUREMENT OF INSULIN ^{125}I BY A LIQUID SCINTILLATION SYSTEM. Logsdon, Donald F. Jr.; Green, James F. (Brooks AFB, Tex.). Radiol. Technol., 40: 223-5 (Jan. 1969).

A secondary method for measuring the radioactivity of insulin ^{125}I samples, produced as the end products of a radioimmunoassay of plasma insulin, makes use of a liquid scintillation counting system. A scintillation counting fluid composed of scintillator, wave length shifter, naphthalene, and p-dioxane, was found to be suitable for counting insulin ^{125}I impregnated filter discs. No quenching effect was produced by the filter discs, the buffer, the plasma, the non-radioactive insulin, or the antibody, the components of the sample. The counting efficiency was found to be 21.4 per cent, compared to 58.5 per cent found with the well-type gamma spectrometer counting system. Although the sample preparation is slightly more difficult with the liquid scintillation system and the efficiency is reduced, this system does provide a useful secondary counting system for insulin ^{125}I samples. (auth)

7968 PROBABLE CAUSE OF HIGH RADIOSENSITIVITY OF CELLS (RADIOSENSITIVITY OF DNA SYNTHESIS) DURING THE S INTERPHASE PERIOD. Ivanov, I. I. (Kirov Academy for Military Medicine, USSR). Dokl. Akad. Nauk SSSR, 182: 963-4 (Oct. 1, 1968). (In Russian).

The overall radiosensitivity of cells depends on the portion which is in a highly radiosensitive stage at the time of the irradiation; this is the S period and the end of the G_1 interphase period, during which the synthesis of DNA becomes very sensitive toward radiation. Injury of one half of the double helix of DNA may cause local activation of the corresponding ferments, resulting in the patching up of the damage structure. Simultaneous injury of both adjacent DNA helices results in an irreversible injury and the death of the cell. These considerations explain the higher radiosensitivity of cells, or more precisely, of the DNA synthesis during the S period and at the end of the G_1 period interphase. The reduplication process requires the temporary unwinding of the DNA helix during these periods, during which the cells are unable to repair or to heal the injury, to form complementary DNA helices from individual polynucleotide links. Thus, the level of injury does not depend only on the damage to individual structures, such as DNA, but on the probability of recovery of the system at the molecular level. (TTT)

7969 CORRELATION BETWEEN THE THIOL-GROUP CONTENT OF THE HEMOPOIETIC TISSUE AND THE RADIOSENSITIVITY OF VARIOUS LINES OF MICE DURING THE POSTNATAL DEVELOPMENT. Tu, Le Suan; Graevskii, E. Ya. (Inst. of Developmental Biology, Moscow). Dokl. Akad. Nauk SSSR, 182: 965-8(Oct. 1, 1968). (In Russian).

The presence of thiol-groups determines in part the radiosensitivity of organisms; correlation was established between the albuminous and low-molecular thiol groups in the hemopoietic tissues which affect the survival rate of mammals exposed to lethal radiation doses. The problem was examined by comparing changes of the $LD_{50/30}$ radiosensitivity during later stages of postnatal development of various lines of mice and the thiol content of their tissue. Mice of the BALB/c, CC57BR and C57BL lines, aged 15, 30, 45, 60, and 90 days, were exposed to 300, 400, 500, 600, and 700 R whole-body x radiation. The probit lines, deviations, and the $LD_{50/30}$ values were determined. The results revealed that the genotypical and age factors affect the thiol group content and the radiosensitivity of the mice; a positive correlation coefficient of 0.82 ± 0.08 was found to exist between the $LD_{50/30}$ and the thiol group content. (TTT)

7970 INCREASE OF THE RADIATION RESISTANCE OF IMMUNOCOMPETENT CELLS IN PREVIOUSLY IRRADIATED MICE. Petrov, R. V.; Cheredeev, A. N. (Inst. of Biophysics, Moscow). Dokl. Akad. Nauk SSSR, 182: 462-4(Sept. 11, 1968). (In Russian).

It has been observed that the radioresistance of animals increases after they have been subjected to radiation; however, the mechanism of this effect has not yet been clarified. In order to identify the process involved, the radioresistance of immunocompetent cells of intact and previously irradiated animals was compared by determining the number of injured cells. Female mice were used for the experiment, either intact or after exposure to 500 R of gamma radiation. The principle of in vivo antibodies after in vitro antigen stimulation was applied with spleen cells. It was found that injection of antigen-stimulated spleen cells from normal mice into recipients exposed to a lethal dose resulted in the accumulation of antibody-producing cells in the spleen; using previously irradiated donors, the transplantation resulted in a smaller number of antibody-producing cells. Tests with exposed cell suspensions from intact and irradiated donors indicated that population of immunocompetent spleen cells of previously irradiated mice is more radioresistant than those of intact animals. The two mechanisms that may be involved in this effect are described. (TTT)

Ecology

Refer also to abstract 9272.

7971 (COO-1329-7) POPULATION DYNAMICS, MOVEMENT, AND HOME RANGE OF BLACK-TAILED JACKRABBITS (LEPUS CALIFORNICUS) IN CURLEW VALLEY, NORTHERN UTAH. Technical Progress Report, July 15, 1966-July 14, 1967. Wagner, Frederic H. (Utah State Univ., Logan. Dept. of Wildlife Resources). July 25, 1968. Contract AT(11-1)-1329. 19p. Dep. CFSTI.

Semi-annual population censuses were continued in October 1967, and March 1968. These were taken extensively over the valley as a whole with 73 one-mile transects distributed at random and traversed on foot. Results showed continuation of the population decline. For studies on reproduction rates, monthly collections of 50 to 150 animals from valley populations were made. The tabulated results show monthly mean litter size by years in adult females, monthly percentage of adult females pregnant by years, and monthly product of mean litter size and pregnancy rate by years. It was found that substantial variation occurred during the period of study and the variations appeared to be associated with density. While reproductive rate is a function of density, changes in density are not a function of reproductive rate. Studies on mortality rates showed some variation between years. No particular trend was evident for the October-March mortality, but the summer adult and juvenile losses were comparatively low in the first year of study (1962-63) and since then have been comparatively high. Variations in population were significantly marked by variations in the very high mortality rates and, consequently, no correlation exists between reproductive rate and population trend. The influence of massive, but sublethal, doses of x radiation on the movement and home range patterns of jackrabbits was studied. Brain tissue was damaged by subjecting animals to 5000 R x radiation administered in 25 min continuous dosage to the cerebral region. The animals were then fitted with radio transmitters, returned to the capture site, and released. Tables are presented to show average of mean hourly distance moved per night of control and test animals and daily average ranges for control and test animals in acres. The data suggest that the home ranges of the irradiated animals are nearly twice the size that of the controls. Both the mean hourly movement and daily average ranges suggest more mobility on the part of the irradiated animals. (H.L.W.)

7972 (NYO-2577-10) A STUDY OF NATURAL RADIOACTIVITY IN BRAZIL. (Pontificia Universidade Catolica do Rio de Janeiro (Brazil)). Aug. 1, 1968. 48p. Dep. CFSTI.

Studies in two areas of high natural radioactivity in Brazil are reported. The areas include Guarapary, in the monazite sand region, and Morro do Ferro, in an area of volcanic intrusives. Thermoluminescent dosimeters were distributed to selected individuals residing in Guarapary and collected approximately six months later. Uncertainties in the dose rate measurements on the environment made by this method are discussed. Measurements of Rn and Th decay products in air and respirable dusts were not satisfactory. A whole-body counter was constructed. Plants collected from the Morro do Ferro area were analyzed for ^{224}Ra and ^{228}Ra. Data on several species of Clethraceae and Melastomataceae are presented. (C.H.)

7973 (NYO-3273-11) RADIOCHEMICAL AND RADIOECOLOGICAL STUDIES ON BRAZILIAN AREAS OF HIGH-NATURAL RADIATION. Annual Report. Penna Franca, E. (Brazil Univ., Rio de Janeiro. Instituto de Biofisica). July 30, 1968. Contract AT(30-1)-3273. 59p. Dep. CFSTI.

Studies in three areas of high natural radioactivity in Brazil are presented. The areas include Guarapary-Meaipe, in the monazite sand region, and Araxa and Morro do Ferro, both in areas of volcanic intrusives. Estimations were made of the annual uptake of heavy radionuclides, particularly ^{226}Ra and ^{228}Ra, from food by members of selected families. A number of foods grown locally were analyzed for ^{226}Ra, ^{228}Ra, and Ca contents. Attempts were made to estimate the body burdens of heavy radionuclides in inhabitants based on results of radiochemical analysis of human bones, teeth, and placental tissues for ^{226}Ra and ^{228}Th. Chromosome aberrations in cultured lymphocytes from peripheral blood were analyzed as a measure of possible biological effects of chronic radiation exposure. The effect of high levels of natural radioactivity on the evolutionary process of native vegetation was also studied and selected plant species were examined for plants with large chromosomes and sterile pollen. A comparison was made of the genetic load and radioresistance of natural populations of Drosophila inhabiting radioactive and normal environments. Plants, mostly Angiosperms, and insects, including grasshoppers, termites, and tiger-beetles, were collected for studies on anatomy, morphology, and genetics. (C.H.)

7974 RADIOACTIVE TRACERS IN THE STUDY OF ENERGY TURNOVER BY A GRAZING INSECT (CHRYSOCHUS AURATUS FAB.; COLEOPTERA CHRYSOMELIDAE). Williams, Eliot C. Jr.; Reichle, David E. (Oak Ridge National Lab., Tenn.). Oikos, 19: 10-18(1968).

Introduction of radionuclides into the old field herb Apocynum cannabinum growing in the field was used to determine radionuclide behavior in insects and the plants under natural environmental conditions. Both nuclides were introduced into plants by stem inoculation. Rubidium-86 and ^{32}P moved readily into the plants when applied by this method and gave a relatively uniform distribution within several hours after inoculation. Biological half-lives of these radionuclides were determined for laboratory cultures of C. auratus to enable calculation of biological turnover rates and, consequently, estimates of radionuclide input and foliage consumption. Localized infestations of Apocynum by the garden webworm Loxostege similalis permitted similar, although not as detailed, studies of the larval stages of this insect as well. Elimination of isotope by beetles that had fed upon tagged plants was used to estimate the rates of food consumption. For individuals at isotopic equilibrium with their food base, isotope input (I) equaled the biological turnover of isotope: $I = kQ_eM/a$, where k is the turnover rate of isotope in the beetles, M mass (mg dry wt), and a assimilation coefficient for the particular radioisotope. If the radioisotope concentration of the food base is known, input also can be expressed as food consumed. Turnover rates (k) were calculated from biological half-lives (T_b), where $k = 0.693/T_b$. The biological half-life of ^{86}Rb in Chrysochus was one day, while that of ^{32}P was 7.5 days in females and 10.2 days in males. The retention curve for ^{86}Rb was characterized by a single, exponential function. Individuals on an inadequate food supply showed a slower turnover of ^{86}Rb, resulting from reduced food intake. Egg production was not an important route of ^{86}Rb loss. The ^{32}P retention curve was characterized by the interaction of two linear exponential functions. (BBB)

7975 HEMATOPATHOLOGIC SURVEYS OF KANGAROO RATS (DIPODOMYS MICROPS) POPULATING PLUTONIUM CONTAMINATED REGIONS OF THE NEVADA TEST SITE. Paglia, Donald E. (Univ. of California, Los Angeles). Contract AT(04-1)-GEN-12. Health Phys., 15: 493-8(Dec. 1968).

Hematologic characteristics were assessed in 765 kangaroo rats indigenous to five ^{239}Pu-contaminated regions and two control areas within the Nevada Test Site. Bone and lung specimens, gastrointestinal contents, and environmental air and soil samples were assayed for ^{239}Pu content. Gross pathologic changes appeared minimal and nonspecific. Mean platelet levels in two exposed groups were slightly lower than control values. One of these groups, for which ^{239}Pu data were unavailable, also exhibited lower mean levels of peripheral lymphocytes. While significant statistically, all blood-cell depressions were physiologically inconsequential. Statistical evaluations disclosed no correlation between available ^{239}Pu burdens and any measured biological parameter. (INIS) (UK)

Genetics and Cytogenetics

Refer also to abstracts 8086, 8091, and 9285.

7976 (UCRL-18066, pp 26-37) RADIATION-INDUCED MITOTIC SEGREGATION IN YEAST. Nakai, Sayaka; Mortimer, Robert K. (California Univ., Berkeley. Lawrence Radiation Lab.).

Studies were made on Saccharomyces cerevisiae following exposure to doses of 15, 40, or 80 k rads of x radiation or to uv radiation. Results indicated that the principal mechanism of radiation-induced sectoring in diploid yeast was mitotic crossing over. Approximately 80% of the colonies were sectored for all genes distal to one of the seven intergenic regions. Genetic analysis showed that these colonies were reciprocal with respect to the genotypes of opposite sectors. A positive correlation between sectoring frequency and centromere distance was observed, as is expected for mitotic crossing over. It was possible that mitotic gene conversion, that should show no centromere dependence, predominated at these high exposures. If only a fraction of the population of cells was competent for mitotic crossing over, this event could saturate at relatively low doses, allowing other events such as gene conversion to predominate. Mitotic gene conversion, i.e., nonreciprocal sectoring, was observed in the present experiments, but in nearly all cases its effect was restricted to single genes. If two or more adjacent genes sectored, the event involved in nearly every case was mitotic crossing over. It is not known if the conversion-type events observed in this study correspond to the intragenic events involved in reversion of heteroallelic diploids. They are analogous to the aberrant 1:3 segregations observed in meiosis of yeast and other fungi. Radiation induces a relatively high frequency of recombination (3% for one chromosome arm) at doses that cause relatively little killing. This role of radiation in altering the genotype of cells that survive radiation might be of importance in assessing the long-term effects of exposure to radiation. (auth)(TSS)

7977 (UCRL-18066, pp 43-7) RADIATION-SENSITIVE MUTANTS IN YEAST. Resnick, Michael A.; Mortimer, Robert K. (California Univ., Berkeley. Lawrence Radiation Lab.).

Three classes of mutants that increase sensitivity to radiation were isolated in yeast (Saccharomyces cerevisiae). They included uv-sensitive, x-ray sensitive, and uv and x-ray sensitive. Another mutant prevented photoreactivation of lethal damage following uv. These mutants were used to study radioinduced recombination, lethality, mutagenesis, and lethal sectoring. (auth)

7978 A STUDY ON THE GENETIC EFFECTS OF OCCUPATIONAL CHRONIC IRRADIATION AMONG CHINESE MEDICAL WORKERS. Tu, Jo-fu; Chiang, Yao-ch'ing; Ch'en, Hsiu-lan. I-ch'uan-hsueh Chi-k'an, No. 5, 1-13(Dec. 1964).

This is the first portion of a report dealing with the genetic effects of occupational chronic irradiation among Chinese medical workers. The experiments were conducted among the medical workers of 46 cities in China. Statistics in chart forms are presented in this paper. (JPRS)

7979 PRODUCING USEFUL MUTANTS OF WINTER WHEAT THROUGH THE ACTION OF FAST NEUTRONS. Hsu, Ch'eng-man. I-ch'uan-hsueh Chi-k'an, No. 5, 59-74(Dec. 1964).

This is part of a study aimed at comparing the mutagenic effect of γ rays, fast neutrons, and ethylenimine on PPG-186 winter wheat. The results of the experiments following three yrs of work are reported. (JPRS)

7980 EFFECT OF VERNALIZATION CONDITIONS AND THERMAL NEUTRON IRRADIATION ON THE DEVELOPMENT OF WINTER WHEAT AND ITS PROGENY. Chu, Chung-ch'un. I-ch'uan-hsueh Chi-k'an, No. 5, 75-90(Dec. 1964).

Data from three yrs of experiments showed that chipped seeds of winter wheat may pass through the vernalization stage at a temperature of –3°C but more slowly than at optimal temperatures for vernalization. If the seeds were vernalized at a temperature below freezing (–3°C) earing was delayed more than in

plants vernalized at 0 to +3°C. Thus all experiments in vernalizing winter wheat at below-freezing temperatures showed that the process may proceed and finish at a temperature of –3°C, even after very short prevernalization at 0 to +3°C and a finishing period at –3°C is distinguishable only quantitatively (the finishing at –3° proceeds slowly). In progeny of these irradiated seeds, earing starts earlier with spring sowing and the percentage of eared plants is higher than in controls. Consequently, irradiation with thermal neutrons contributes to more forcefully shaking the heredity of plants. Irradiation with a dose of thermal neutrons of 1×10^{11} per sq. cm. produced plants with longer ears, larger grains than in controls. These changes were hereditary in nature. (JPRS)

7981 IONIZING RADIATION IN AGRICULTURE. Gulamov, M. K.; Narimov, S.; Atazhanov, M. A.; Rykhsikhodzhaev, T. Khlopkovodstvo, 10: 39-41(Oct. 1965). (In Russian).

The heredity and mutability of five selected varieties of cotton seeds were studied with ^{60}Co γ rays at doses of 100 to 100,000 R and at 10, 100, 500, and 620 R/min, also at 16, 22, 26, 100, and 500 R/sec. The experiments were replicated four times, and 350 to 400 plants of each variety were used. Observations revealed that, with the increased radiation doses, changes in morphology of the plants appeared coupled with hybrid vigor, dwarfism, both late and early maturation of plants, stimulated and inhibited fecundity, also plants with larger and smaller than normal bolls and leaves. Doses above 5000 to 10,000 R rendered a considerable number of plants semisterile. However, a three-yr research program showed that the most effective exposure for cotton breeding improvements were γ-ray doses of 50,000 R at 10 to 620 R/min, or doses from 20,000 to 30,000 R at 16, 26, and 500 R/sec, also 15,000 R at 100 R/sec. After a discussion of the advantages and disadvantages of radiation with respect to mutability of the five varieties of cotton seeds and their plants, in conclusion one aspect of cotton plant breeding was emphasized. While many new plant varieties lacked impressive gains of growth in the first generation (M_1), they showed considerable productivity gains in M_3 and particularly in M_4 (fourth generation), that is, by having much longer fibers, of better quality, and in larger amounts. Thus, radiation appeared to be a useful mutagenic agent for obtaining variants for cotton breeding programs. (BBB)

7982 DETERMINING THE REPAIR RATE FOR RADIATION-INDUCED CHROMATID DELETIONS DURING THE FIRST 24 HOURS AFTER IRRADIATION. Brooks, A. L.; Lengemann, F. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2147. Radiat. Res., 36: 181-92(1968).

The number of chromatid plus isochromatid deletions present in the testes and bone marrow of the Chinese hamster was measured as a function of time following acute exposure to ^{60}Co γ irradiation. The number of breaks remaining scorable at any time after irradiation exposure could be represented by a simple exponential equation ($N = N_0e^{-kt}$). The values of N_0 and K, calculated after 100 R of γ irradiation, were 1.15 breaks/cell and 0.16/hr, respectively, for the testes, and 0.53 break/cell and 0.14/hr, respectively, for the bone marrow. The average length of time that the breaks remain scorable, 1/k, was 6.3 hr for the testes and 7.1 hr for the bone marrow. By suitable formulation, it was possible to predict the number of breaks present by using varied radiation exposure rates and times after exposure. This formulation could be used for both single and multiple radiation exposures. (auth)

7983 STUDIES ON THE GARLIC BREEDING USING RADIATION. II. MORPHOLOGICAL EFFECTS ON GAMMA RAY INDUCED R_1 GENERATION IN GARLIC ALLIUM SATIVUM. Harn, Chang Yawl; Choi, Jin Kyu; Koh, Young Seu (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 8: Pt. 2, 121-5(Aug. 1968). (In Korean).

The present study was carried out in order to induce useful mutations in garlic. The garlic bulbs were exposed to 800, 1,100, 1,400, and 1,700 R of γ ray. The germination rate was not affected by high doses of γ ray but the length of the germination period was prolonged. The survival rate at maturity period showed a great decrease in the populations exposed to high doses. Significant variations were observed on plant height, clove number per bulb, and bulb diameter and weight. Various morphological changes were observed on many parts of the plants. The biological effects of γ ray increased in proportion to their chromosomal aberrations at anaphase of root tip mitoses. (auth)

7984 INCREASING MUTATION FREQUENCY IN RICE THROUGH REIRRADIATION. Soriano, Joventino D. (Univ. of Philippines, Quezon City). Natur. Appl. Sci. Bull., 19: 81-90 (Apr.-June 1965).

Moist R_2 rice seeds from a previous 15 Kr γ-radiation treatment were reirradiated at doses ranging from 15 to 75 Kr. The seeds were grown for cytogenetic study. No difference was observed in seedling growth response and in frequency of bridge-bearing cells in R_1 and $2R_1$ root tips. This is caused by the physiological nature of induced growth retardation and to the somatic location of root-tip aberrations. Increase in the frequency of the yellow-striped somatic mutation, interchanges and seedling mutations is believed to be caused by accumulation of such induced changes. A possible explanation for the apparent selective action in favor of albino and yellow-green mutations was discussed briefly. (auth)

7985 BIOCHEMICAL AND GENETICAL STUDIES ON RADIORESISTANT MOUSE CELLS IN CULTURE. Horikawa, Masakatsu. (Kyoto Univ.). Idengaku Zasshi, 43: 349-64(Oct. 1968).

A cell line resistant to γ-irradiation was isolated from the original mouse strain L cells after seven successive irradiations with total dose of 14,000 R and was designated Lγ7. The various biochemical and genetical properties of these resistant cells were investigated. The Lγ7 cells manifested a resistance to radiation, although the degree of resistance was not so high. The mean generation time of the original L cells was 27 hours during the logarithmic phase of growth, whereas that of the Lγ7 cells was 84 to 90 hours. Their cell morphology also differed from that of the original L cells; the Lγ7 cells were spherical, whereas the original L cells were fibrous. The lower metabolic activity of oxidative phosphorylation in the Lγ7 cells seems to have a relation to their reduced multiplication rate and radioresistance. Furthermore, the content of SH groups per cell in both protein and non-protein SH reactions was significantly greater in the radioresistant Lγ7 cells than in the original L cells. The high content of SH groups in the radioresistant cells also may have some relation to their radioresistance. The original L cells had a mode of chromosome number at 63. The Lγ7 cells had a mode of 44 chromosomes. Thus there was a shift in chromosome number. This decrease in chromosome number in the latter cells was gradually derived by seven repeated γ-irradiations of 2,000 R each. A similar phenomenon was observed in the changes in number of chromosomes in irradiated Ehrlich ascites tumor cells. The original Ehrlich ascites tumor cells had a mode around 58 chromosomes, whereas EX4 cells, isolated after four successive irradiations with total doses of 8,000 R of X-rays, had a mode of 51 chromosomes. In the present investigation it was indicated that a correlation may exist between chromosome number and radioresistance in mammalian cells. In addition, the gradual shift in the chromosome number of the radioresistant cells (Lγ7 cells and EX4 cells) from the original L cells and Ehrlich ascites tumor cells seems to suggest that radioresistant cells may be derived from the pre-existing resistant cells in the original unirradiated population. (auth)

7986 ONTOGENETIC AND MUTATIONAL VARIABILITY OF PULLULARIA SP. Egorova, V. N.; Inge-Vechtomov, S. G. (Univ., Leningrad). Genetika, 4: 136-43(Nov. 1968). (In Russian).

The fungi characterized by the mold-yeast dimorphism can be used as model systems for the investigation of the processes of cytodifferentiation. Ontogenetic variability, expressed as the alternation of gemmation and mycelial growth, is observed in the fungus Pullularia sp. Mutants with disturbed cytodifferentiation were induced by uv-light. In these mutants the colonies developed either by gemmation, or by means of mycelial growth. These defects were not compensated by any components of the complete medium. Besides, mutants with abnormal morphology and pigmentation of colonies were obtained, as well as biochemical mutants. Of the greatest interest from the standpoint of investigating the problems of cytodifferentiation are the mutants, the ontogenic variability of which can be controlled by the composition of the culture medium. On the complete medium the colonies of these mutants developed by means of alternation of gemmation and mycelial growth, while on the minimal medium the development of the colonies proceeded by means of gemmation only. Two of these mutants required lysine for the development of mycelium. It was observed that the cytodifferention in Pullularia sp. affects the structure of the cell wall, the result of which is the increased sensitivity of the hyphae to the enzymes of the digestive juice of snails, as compared to the yeast-like cells. (auth)

7987 CHLOROPHYLL-DEFICIENT MUTANTS IN TOMATO REQUIRING VITAMIN B_1. I. GENETICS AND PHYSIOLOGY. Boynton, John E. (Univ. of Copenhagen). Hereditas, 56: 171-99(1966).

The genetics of three thiamine-requiring tomato mutants with chlorophyll-deficient phenotypes were studied: two radioinduced mutants (ten and spa) and a spontaneous mutant (tl). The localization of their respective genetic blocks in the biosynthetic path-

way of thiamine was investigated, and a comparison was made of the physiological behavior of the mutants when grown on different levels of exogenous thiamine. Two non-allelic mutants, tl and spa, were blocked in the biosynthesis of the pyrimidine precursor of the thiamine molecule, as evidenced by their responses to exogenously supplied pyrimidine. Adaptive growth occasionally shown by spa indicated that it was a leaky mutant, while the unfailing lethality of tl showed the completeness of its biosynthetic block. The ten mutant required both the pyrimidine and thiazole precursors or intact thiamine. Thiamine or its two precursors produced a subnormal phenotype in ten. Yellowish epicotyls of ten contained normal amounts of free thiamine, but less than 15% of normal phosphorylated thiamine. This evidence suggested that ten was unable to phosphorylate thiamine. The ability of exogenous thiamine to stimulate this mutant might be explained in terms of the creation of an abnormally large pool of endogenous thiamine that effects a limited phosphorylation of thiamine by forcing a partially blocked reaction to completion. (BBB) (TSS)

7988 SUBMERGED KOJIC ACID FERMENTATION BY γ-IRRADIATED STRAIN OF ASPERGILLUS ORYZAE. Kawate, Shohei (Kansai Univ., Japan); Makino, Nobuhide. Kogaku To Gijutu, 2: No. 2, 98-103(Nov. 1965). (In Japanese).

In order to get higher acid yielding strains, the induction of mutants by γ irradiation, in Aspergillus oryzae strain A 11 producing kojic acid (KA), was investigated, and the effects of the composition of the culture medium on submerged KA fermentation in the shake flask were also studied. Among the γ-irradiated organisms, some strains were found to produce several times as much KA as the parent strain in K (Kinoshita) medium. Dry mycelial weights showed small values compared to other fungus fermentations. Strains producing titrable total acid higher than 0.11 N, mainly produced succinic acid. In the case of high KA productivity, generally, final pH of the broth was about 3.0 to 3.2. Using the superior KA producer found above, γ-1036 and γ-1057, the highest KA accumulation by the shake culture was obtained with the following composition of culture medium; glucose 100 g., NH_4NO_3 0.5 g., KH_2PO_4 2.0 g., $MgSO_4 \cdot 7H_2O$ 0.7 g. in 1 liter, and initial pH 3.5 adjusted by adding HCl. (auth)

7989 THE EFFECT OF GAMMA-RAYS ON HUMAN CHROMOSOMES. II. THE DEPENDENCE OF CHROMOSOME ABERRATIONS FREQUENCY UPON SEX AND AGE. Bochkov, N. P.; Pilosov, R. A. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 4: 144-50(Nov. 1968). (In Russian).

Human lymphocytes of 39 persons were gamma-irradiated in vitro at a single dose of about 100 R prior to culturing. The frequencies of chromosome aberrations in the first post-irradiation metaphases were studied. By various tests it was determined that the cytogenetic radiosensitivity was higher in the children (up to 11 years old) and in the men 55 to 65 years old than in the group of 20 to 40 years old. There are not any differences in the frequencies of chromosome aberrations between men and women. (auth)

7990 MUTANT OF BACILLUS SUBTILIS PRODUCING ULTRAVIOLET-SENSITIVE SPORES. Munakata, Nobuo; Ikeda, Yonosuke (Tokyo Univ.). Biochem. Biophys. Res. Commun., 33: 469-75(Nov. 8, 1968).

A mutant of Bacillus subtilis producing UV-sensitive spores was isolated. This mutant was derived from a mutant producing UV-sensitive vegetative cells. In the new isolate, the spores were almost as sensitive to UV irradiation as the vegetative cells. Spore-specific protection or repair mechanism is discussed. (auth)

7991 MUTATION BREEDING IN TRITICUM DURUM. Scarascia Mugnozza, G. T. (CNEN, Rome). Abh. Deut. Akad. Wiss. Berlin, Kl. Med., No. 2, 205-10(1967). (RT/BIO-(68)27).

Mutations were induced in five varieties of durum wheat by treating seeds with x rays, fast and thermal neutrons. Yield, yellow berry, height, and lodging were tested in 127 mutant lines. Crossing experiments were carried out on mutant lines and results are tabulated. It was concluded that improvements resulted from induction of mutations and cross-breeding methods. (H.L.W.)

7992 CHROMOSOME ABERRATIONS INDUCED BY PLASMA FROM IRRADIATED PATIENTS: A BRIEF REPORT. Hollowell, Joseph G. Jr.; Littlefield, L. Gayle (Medical Coll. of Georgia, Augusta). J. S. C. Med. Ass., 63: 437; 442(Dec. 19, 1967).

The effect of plasma from x-irradiated patients on the chromosomes of normal, nonirradiated lymphocytes was studied in short-term cell culture. This experiment was devised to separate the direct effects of x rays from a possible indirect, humoral effect on chromosomes. Cell-free plasma (1.5 ml) from six patients x irradiated for a variety of tumors (so-called irradiated plasma) was added to normal nonirradiated cells in culture. For controls, autologous or nonirradiated homologous plasma (normal plasma) and plasma from six patients with comparable tumors, not yet irradiated, was used (nonirradiated plasma). In scoring cells, the chromatid was considered broken only if the distal fragment was displaced or misaligned. Otherwise, it was considered to be a gap. Breaks occurring in the same region of sister chromatids were classified as chromosome breaks. In cells treated with irradiated plasma, there were more gaps than in either of the controls whereas there was no difference in the frequency of chromatid breaks in the two control groups (normal plasma, 3.6/100 cells, and nonirradiated plasma, 4.2/100 cells); the frequency of breaks was higher when irradiated plasma was used (10.7/100 cells). Similarly, the frequency of chromosome breaks was higher in the irradiated plasma group (7.1/100 cells) compared with normal plasma (0.9/100 cells). In the control groups only one transformed chromosome, an exchange figure, was seen in a culture with autologous plasma. In the irradiated plasma group three dicentric chromosomes, one ring chromosome, and one quadriradial exchange figure were seen. Excluding gaps, 16.9% of the cells of the irradiated plasma group contained abnormal chromosomes, compared with 3.9% in the nonirradiated group and 4.1% in the normal plasma group. The differences between the irradiated plasma group and either of the other groups were highly significant. Many cells treated with irradiated plasma had clumped chromosomes and stranding among the chromosomes, rarely seen in the control groups. (BBB)

Health Physics and Safety

Refer also to abstracts 7440, 7640, 7654, 7661, 7727, 7729, 7731, 7733, 7738, 7801, 7871, 7934, 7975, 8016, 8047, 8059, 8080, and 9110.

7993 (AEC-tr-6866) MINISTRY OF SOCIAL AFFAIRS. DECREE NO. 67-228 OF MARCH 15, 1967, CONCERNING A PUBLIC ADMINISTRATION REGULATION RELATIVE TO THE PROTECTION OF WORKERS AGAINST THE DANGERS OF IONIZING RADIATION. ORDER OF MARCH 17, 1967, RELATIVE TO THE COMPETITIVE EXAMINATION FOR PHYSICIANS FOR APPOINTMENT TO THE GENERAL DIRECTORATE OF PSYCHIATRIC HOSPITALS. Translated from J. Offic. Repub. Fr., 99: 2738; 2754-72(1967). 58p. Dep. CFSTI. JCL $5.60 fs, $1.94 mf.

In consideration of the opinion of the French Atomic Energy Commission, a decree is presented in which articles are listed stating modes of irradiation, maximum permissible dose equivalents and concentrations, and fields of application. Additional articles are given concerning general provisions relating to all operations involving a risk of irradiation or contamination; measures of a technical nature relating to the controlled zone; measures of medical nature relating to the personnel of the controlled zone; measures relating to the work yards or places adjoining the controlled zone, and to the workers employed in these work yards or places; special provisions for certain radiation sources; special provisions applicable in the prevention, diagnosis, nursing or treatment centers, and to the private medical or dental consulting rooms; and temporary measures. Appendices are included on definitions of mass activity, maximum permissible concentration, dose equivalent rate, and other terms; a list of groups of radioisotopes according to their radiotoxicity; maximum permissible dose equivalents; quality factors and maximum neutron fluxes; and maximum permissible concentrations. (H.L.W.)

7994 (EUR-3945) COMPARISON OF THE RADIOACTIVE CONTAMINATION OF THE TOTAL DIET OF ADOLESCENTS IN THE COMMUNITY. 1. INTERLABORATORY COMPARISON PROGRAMMES. RESULTS AND COMMENTS. van der Stricht, E. (European Atomic Energy Community). Apr. 18, 1968. 72p. Dep.

Since October 1965, a comparative study on radioactive contamination of the total diet of adolescents has been in progress in the Community countries. As part of this study, two programs for comparison of the results provided by the laboratories responsible for performing the measurements have been carried out. They relate to the measurements of strontium-90, cesium-137, calcium, potassium, stable strontium, and radium. The results obtained are presented and evaluated statistically. The first program shows that the strontium-90 and potassium results are satisfactory, whereas the cesium-137 and calcium measurements are less so. The second program, carried out by agreement with the International Atomic Energy Agency, enabled several laboratories not only to re-examine their analysis and measurement techniques but also to check their counter calibration again. At the time of writing, the majority of the laboratories have obtained accuracies to within 5–10% ($p = 0.01$) in the case of strontium-90, cesium-137, calcium, and potassium. It is also believed that no

further improvement would be achieved by repeating such intercomparisons. An appendix to this document contains an assessment of the systematic errors liable to be committed during strontium-90 determination, as well as particulars of reviews dealing with methods of analyzing calcium, stable strontium, cesium-137, and potassium. (auth)

7995 (HASL-200(App.)) FALLOUT PROGRAM. Quarterly Summary Report, June 1–September 1, 1968. Appendix. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct. 1, 1968. 364p. Dep. CFSTI.

Data from the fallout program of the Health and Safety Laboratory for the period June 1, 1968 to September 1, 1968 are presented in tabular form. Information on fallout activity is presented in the following areas: monthly depositions of ^{89}Sr and ^{90}Sr at selected world land site stations; strontium-90 deposition at Atlantic Ocean weather stations; radioisotope determination in surface air samples throughout the world; strontium-89 and -90 content of milk in New York; and ^{90}Sr and ^{137}Cs content of tap water in New York. Tables of conversion factors and radioisotopes are also included. (E.R.B.)

7996 (LA-DC-9774) COMPARISON OF BIOCHEMICAL ASSAY IN INDUSTRIAL HYGIENE AND HEALTH PHYSICS. Schulte, Harry F. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 20p. (CONF-680921-1). Dep. CFSTI.

From Tennessee Valley Industrial Health Conference, Gatlinburg, Tenn.

The technique of excreta analysis is used in industrial hygiene in conjunction with exposure to lead, trichloroethylene, carbon disulfide, fluorides, uranium, mercury, cadmium, nickel, thallium, and thorium. In health physics it is used for plutonium, uranium, polonium, tritium, radium, amercium, barium, ^{210}Pb, ^{230}Th, zirconium, strontium, and zinc. The purpose of the urine assay in industrial hygiene is to compare the results obtained with standards based on human exposures where measured levels of excretion are associated with a demonstrated probability of a biological effect. In health physics the purpose is to estimate a radiation dose to the body or an organ for comparison with standards. Comparisons are made between industrial hygiene and health physics with regard to actual use of data, methods of sampling, the time factor as applied in evaluation of data, and the significance of urine assay results. Graphs are presented to show urinary excretion of lead during constant chronic exposure, idealized buildup of urinary excretion during chronic exposure, relative excretion rates following acute exposure to partially soluble compounds, and plutonium excretion following acute exposure to an insoluble compound. (H.L.W.)

7997 (LA-DC-10003) BIOLOGICAL TREATMENT OF LIQUIDS. Fowler, E. B.; Christenson, C. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 10p. Dep. CFSTI.

From Basic Training Course in Management of Radioactive Wastes, IAEA–Brazil CNEN, Rio de Janeiro, Oct. 14–25, 1968. radioactive wastes 18G

A basic training course in the management of radioactive wastes is presented in brief. Primary consideration is given to the types of equipment used in the treatment of human wastes including: Imhoff tanks, where solid sludge is digested by microbial populations; primary sedimentation tanks, where settleable solids are separated from liquid components of the waste thus facilitating the activity and capacity of the Imhoff tanks; and trickling filters, where the liquid components of the waste are biologically decomposed. Two other processing systems are described, i.e., activated sludge process, and waste stabilization (oxidation) pond. Mechanisms of uptake by microbial films in activated sludge tanks are discussed with particular reference to cationic-exchange processes by which various ions are removed. Adsorption, assimilation, precipitation, and reduction methods for removing radioactive species from waste are also discussed. It is mentioned in conclusion that owing to the radioresistance of microbial populations in general, biological sewage treatment facilities would be unapproachable by humans long before a concentration of radioactive materials would be achieved that could adversely affect the performance of the microbial populations in the treatment facilities. (E.R.B.)

7998 (NP-17624) ANNUAL REPORT FOR THE YEAR 1967. (National Radiation Lab., Christchurch (New Zealand)). 53p. (NRL-AR-18). Dep.

Activities of the National Radiation Laboratory of New Zealand during 1967 are reviewed. Radiation protection programs for users of radiation sources and radioisotopes for medicine, research, and industry are discussed. The content of ^{137}Cs, ^{89}Sr, and ^{90}Sr from fallout in milk samples collected at various locations was measured and total β and γ activity in samples of air particulates and rainwater was determined. The content of ^{131}I in milk and thyroid glands of cattle was also measured. The Laboratory provided assistance in setting up a National Radiation Protection Service in Thailand. (C.H.)

7999 (NP-17647) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 6. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). June 1968. 21p. Dep.

Data are presented on the content of ^{137}Cs, ^{89}Sr, and ^{90}Sr in samples of milk and the total β activity from fallout in samples of air particulates and surface waters collected at various locations in Canada during May 1968. Data are included on radioactivity in the environment in the vicinity of nuclear reactors during the same period. (C.H.)

8000 (RT/PROT-(68)11) PURPOSES AND TASKS OF THE MEDICAL SERVICE IN A NUCLEAR RESEARCH CENTRE. Strambi, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 13p. (In Italian). (CONF-680449-1). Dep.

From ENPI Conference on Medical Science, Naples, Italy.

Work in a nuclear research center entails both radiological risks (deriving from external radiation or radioactive contamination) and conventional ones that may, in some cases, bear a synergetic effect. The importance of routine clinical and radiotoxicological examinations in radiation protection of personnel is stressed. (auth)(TSS)

8001 (RT/PROT-(68)12) IMPORTANCE OF THE HAEMOGRAM IN EVALUATING A PERSON's FITNESS FOR RADIATION WORK: SURVEYS CONDUCTED ON 1,673 PEOPLE. Strambi, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 21p. (In Italian). (CONF-671136-1). Dep.

From 18th National Conference on Analytical Medicine and Pathology, Florence, Italy.

The peripheral blood of 1,673 workers of both sexes (1,433 men, 240 women) were examined prior to their employment in a nuclear research center. The total and differential blood cell counts and the usual hematological parameters (such as hemoglobin, hematocrit, etc.) were carried out by standarized techniques. The results within a 95% confidence limit, suggested a statistical criterion of normality for the examined population. This criterion should, however, be considered as a merely provisional one, since it refers only to one test per individual and does not take into account the large intra-individual fluctuations, especially as regards the leukocyte values of some people. (C.H.)

8002 (UCRL-18066, pp 108-22) CALCULATION OF THE PHYSICAL CHARACTERISTICS OF NEGATIVE PION BEAMS: ENERGY-LOSS DISTRIBUTION AND BRAGG CURVES. Curtis, Stanley B.; Raju, Mudundi R. (California Univ., Berkeley. Lawrence Radiation Lab.).

The physical properties of a stopping negative pion beam were studied in connection with dosimetry experiments with such beams at the Berkeley 184-inch cyclotron. Calculations were made of the dE/dx distribution in the stopping pion region, and central-axis depth-dose curves (Bragg curves) were computed with the assumption of a uniform parallel incident beam with a large enough cross section so that multiple scattering could be neglected. A Gaussianly distributed incident momentum spread was assumed such that the width of the Bragg peak in the stopping region due to momentum straggling was large compared with range straggling effects. This approximated well the experimental situation. Although the calculations were carried out with water as the stopping medium, comparison of the resulting Bragg curve with an experimental curve obtained with a silicon detector showed good agreement. This result implied that the nuclear products emerging from a silicon nucleus after pion capture do not alter significantly the dose in silicon from the dose expected in water. Thus it appears that silicon detectors can be used to obtain information on dose distributions of stopping pion beams in water phantoms. (auth)

8003 (UCRL-50163(Pt.3)(Rev.1)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. III. BIOLOGICAL GUIDELINES FOR DEVICE DESIGN. Burton, C. Ann; Pratt, Michael W. (California Univ., Livermore. Lawrence Radiation Lab.). June 19, 1968. Contract W-7405-eng-48. 28p. Dep. CFSTI.

When a thermonuclear device is detonated, many nuclear particles are released. The types of particles that may be present, namely n, p, d, t, γ, ^3He, and α, and their energies are discussed. These particles interact with both the device materials and the soil components to create radionuclides that may be an internal biological hazard to man. A method was developed, combining a simplified physical situation with the available biological data, that allowed a worst case estimate of the biological hazard. The method points out which cross sections are important and which

cross sections can be neglected still with the guarantee that there will be no surprise reactions that could contribute significantly to the biological hazard. The method also shows how precisely one must know the concentration of a device impurity or a soil component to guarantee that its contribution to the hazard is well below the biological hazard of those elements that are known. The analysis can also show which of several elements or which stable isotopes of a particular element are most promising for the design of a device with the lowest possible biological hazard. A number of examples of the application of the method are given. (E.R.B.)

8004 (UCRL-50163(Pt.4)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. IV. HANDBOOK FOR ESTIMATING THE MAXIMUM INTERNAL DOSE FROM RADIONUCLIDES RELEASED TO THE BIOSPHERE. Ng, Yook C.; Burton, C. Ann; Thompson, Stanley E.; Tandy, Robert K.; Kretner, Helen K.; Pratt, Michael W. (California Univ., Livermore. Lawrence Radiation Lab.). May 14, 1968. Contract W-7405-eng-48. 171p. Dep. CFSTI.

Part IV of this series is a special-purpose handbook for estimating the maximum internal dose to man from radionuclides released to the biosphere. This handbook, that is to be continuously updated and expanded, lists the pertinent data for all isotopes whose half-lives are greater than 12 hr. The first issue is devoted to estimation of the dosage resulting from contamination of agricultural lands as described in the previous parts of the UCRL-50163 series. (auth)

8005 (VUF-1038) ON-SITE HEALTH AND SAFETY REPORT. Project STERLING. Mehas, T. C.; Tappan, J. T. (comps.) (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev. Radiological Sciences Dept.). Feb. 1967. Contract AT(29-2)-162. 21p. Dep. CFSTI.

The Project Sterling Event was detonated at the Atomic Energy Commission's Project Sterling Test Site, Tatum Salt Dome near Hattiesburg, Mississippi, on December 3, 1966. The device was placed at a depth of about 2,700 feet in the center of the 110 foot cavity created by the Project Dribble-Salmon Event. The designed yield was equivalent to 350 tons of TNT. The radiation monitoring program and safety procedures used before and after the event are discussed. (auth)

8006 (ZFK-128) THE LINEAR ENERGY TRANSFER (LET) AS A BASIS FOR INTERPRETATION OF RADIATION BIOLOGY EXPERIMENTS. Rossbach, Heinz (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Aug. 1967. 132p. (In German). Dep.

The relation between absorbed radiation dose, LET distribution, and LET average values was calculated for various charged particles, fast neutrons, and photons of various energies were compared using water as the comparison medium. The applicability of these parameters to analysis of exponential survival curves on the basis of the hit-theory is discussed. The LET distribution was calculated for electrons, protons, deuterons, α particles, and C^{6+}, N^{7+}, and O^{8+} nuclei as a function of the particle energy by the Bethe formula and is given in the form of curves. The absorbed dose calculated by the Bethe formula for electrons, protons, α particles, and C^{6+}, N^{7+}, and O^{8+} nuclei with energies greater than 2.4 keV, 70 keV, 3 MeV, 100 MeV, 150 MeV, and 200 MeV agreed with the measured values. For fast neutrons with energies between 1 and 20 MeV the LET distributions and LET average value for various limiting energies $\geq$0.1 keV for both the first collision and multiple collision cases. The LET distributions and LET average values for photons published by various authors are compared. 63 references. (tr-auth)

8007 RADIO-ISOTOPE RENOGRAPHY IN PYELONEPHRITIS OF PREGNANCY. Gecelter, L. (Johannesburg Hospital). S. Afr. Med. J., 41: 965-9 (Oct. 7, 1967).

Radiological investigation of pregnancy pyelonephritis was handicapped by fear of radiation hazards, and its use was contraindicated in all but exceptional circumstances. The use of radioisotope renography in pregnancy had received very little attention and changes occurring in both normal and abnormal pregnancy were not adequately described. This was probably due to lack of knowledge of the radiation hazard involved to both mother and fetus and its relative contraindication as a research tool in the investigation of normal changes occurring in pregnancy. However, it was shown that the maternal radiation dose was small. With a dose of 10 μCi of ^{131}I-Hippuran the exposure is 4 mR, which was about 1% of the radiation dose received in excretory pyelography. The fetal dose consists of external irradiation from the mother and radioactive tracer entering the placenta; the former was probably negligible. On investigation of material obtained from therapeutic abortions at 10 to 12 weeks of gestation, it was shown that less than 1% enters the fetus, and likewise samples from cord blood, amniotic fluid, and infant's urine suggest that this dose was harmless to the normal full-term infant. Considerably less than the 1 R maximum dose of radiation allowed to pregnant women by the International Commission on Radiological Protection (ICRP) was administered in this investigation. Radioisotope renography using ^{131}I-Hippuran was performed in 20 patients with pyelonephritis of pregnancy. All the patients in this series delivered and no untoward effects to either mother or infant attributable to the test were noted. (BBB)

8008 RADIOACTIVE CONTAMINATION OF MILK IN POLAND IN THE PERIOD 1961-1967 WITH RELATION TO THE NUCLEAR WEAPON TESTS PERFORMED IN 1961-1962. Szulc, Marcin. Nukleonika, 13: 1026-33(1968). (In Polish).

Dry milk specimens, sampled every month in the years 1961 to 1967, were examined. The total artificial β activity, the activity of ^{90}Sr and ^{137}Cs were estimated. The results obtained indicated that nuclear tests that took place in 1961 to 1962 gave rise to a high increase of the milk contamination level in Poland beginning with the second quarter of 1962. The total artificial β activity was found to be highest in the second quarter of 1964 but it has gradually decreased since then. The level of milk contamination with ^{90}Sr was increasing till the second quarter of 1966, and the level of milk contamination with ^{137}Cs showed the same tendency till the first quarter of 1966. The highest content of both these nuclides in milk was observed in the third quarter of 1965. The results show a considerable monthly and quarterly variation in the milk contamination, and a great dependence of the level of milk contamination on the annual rainfall in the sampling regions. (auth)

8009 POTENTIAL HAZARDS OF $^{14}CO_2$ IN THE BIOSPHERE. Joftes, David L. (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Cancer Bull., 20: No. 5-6, 46-8(1968). (NYO-3777-16).

Mice were maintained in plexiglas chambers, one containing $^{14}CO_2$, the other unlabeled CO_2. Air input and output as well as input from the normal and radioactive CO_2 supply tanks were monitored continuously by predictability flow meters. Total CO_2 content of input and effluent air was determined every second day by means of infrared absorption. At the same time, ^{14}C content was measured by absorption of CO_2 from samples of air into hydramine, aliquots of which were submitted to liquid scintillation counting. The mice were kept 70 days in the chamber to establish equilibrium between ^{14}C levels in the atmosphere and in the mice; they were then killed and the tissues analyzed for ^{14}C content. The highest ^{14}C content occurred in fat tissue. Tissue with high nuclear content, such as spleen, contained about two thirds as much ^{14}C as did fat. (H.L.W.)

8010 ^{55}Fe IN NORTHERN SWEDEN; RELATIONSHIPS AND ANNUAL VARIATION FROM 1956 UNTIL 1967 IN LICHEN AND REINDEER AS WELL AS UPTAKE AND METABOLISM IN MAN. Persson, R. B. R. (Univ. of Lund, Sweden). Health Phys., 16: 69-78 (Jan. 1969).

The ^{55}Fe activity from nuclear weapons debris was investigated in lichen, moss, reindeer and man. Lichen and moss were collected from 1956 until 1966 at different places in the world. After the nuclear weapons tests of 1956-58, the activity of ^{55}Fe in lichen was about 10 nCi/kg dry weight. The activity increased rapidly after the high yield events in 1961 and 1962 and reached a maximum value of about 100 nCi/kg dry weight. Reindeer meat samples were collected from 1961 until 1967 at Funäsdalen in northern Sweden. There seemed to be a seasonal variation of the ^{55}Fe activity in the meat similar to that of ^{137}Cs. The maximum values reached in April 1965, 1966 and 1967 were about 400 nCi/kg dry weight. The biological halftime of iron in reindeer was estimated to be about 150 days. The body burden of ^{55}Fe was estimated by analyzing blood samples from Lapps and non-Lapps. No significant seasonal variation of the ^{55}Fe activity was found. The biological halftime of the iron was also estimated. The average annual absorbed dose to the red blood cells during 1965-67 was estimated to be 5 mRad for female Lapps and 2.5 mRad for male Lapps. Because of the high iron concentration in the iron storage proteins, ferritin and haemosiderin, their annual absorbed dose in female and male Lapps was about 800 and 400 mRad respectively. The absorbed dose to be received by the year 2000 from ^{55}Fe released in the major periods of nuclear weapon testing was estimated. (auth) (UK)

8011 GOAT THYROIDS AS INDICATORS FOR ROUTINE ENVIRONMENTAL MONITORING OF RADIOIODINE. Bhat, I. S.; Kamath, P. R. (Tarapur Atomic Power Project, India). Health Phys., 16: 65-7 (Jan. 1969).

Radioiodine monitoring in a reactor environment is important for the detection of any unwarranted radioactivity release. Bovine thyroids were examined for monitoring iodine in various estab-

lishments in the U. S. In India, cows' thyroids are not available, whereas goats are slaughtered for meat and the thyroids are freely available. The results are given of a survey to determine radioiodine content in goat thyroids in the Tarapur Atomic Power Project environment, and on associated investigations for the use of goat thyroids as indicators for radioiodine. The study showed that the goat thyroid weighs 1.9 ± 0.1 g and the average iodine content is 1 mg/g thyroid. Comparison of the iodine content in the thyroid tissues with that of goats and cows' milk showed that the thyroid has nearly 20,000 times higher iodine content. Monitoring of thyroids in 1967 did not show any activity in May (premonsoon period), but in August the thyroids showed considerable amounts of ^{131}I, probably due to the French weapons test in July. In this period an examination of grass, milk (cow's) and goat thyroids showed that ^{131}I in a gram of thyroid tissue corresponded to that in 8 kg of grass and in 13.5 l of milk. In January, 1968, thyroids again showed radioiodine, following the Chinese test in December 1967. (auth) (UK)

8012 NEW DOSE ESTIMATES FROM CHRONIC TRITIUM EXPOSURES. Evans, A. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 16: 57-63(Jan. 1969).

Estimates of the radiation dose from assimilation of tritium oxide, the common form of environmental tritium, are based on the assumption that tritium remains in body water until excreted. Analyses of deer tissues, however, indicate that chronic exposure to tritium causes significant labeling of organic molecules. The degree of labeling was determined from tritium assays of seven tissues (heart, liver, kidney, spleen, brain, muscle, and fat) from 52 deer collected on the Savannah River Plant site. In most tissues the tritium-to-hydrogen ratios in both body water and the water of combustion of dried tissues were the same. This incorporation of tritium in the organic component of deer tissue results in whole body doses 1.4 to 1.5 times higher than estimated if only tritium in body water is considered. (auth) (UK)

8013 DECONTAMINATION OF FISSION PRODUCTS ON HUMAN SKIN AND HAIR. Nishikawa, Yasushi; Nishioka, Hajime (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 77, 1-9(Mar. 1967).

The powerful chelating agents, EDTA and DTPA' were investigated for the purpose of decontamination of fission products on human skin and hair, and measurements were made on the decontamination percentage (Dt) for the total activities, the variation of decontaminated radioactivities per unit volume of eluting solution, and the decontamination percentage (Dn) for each γ-emitting nuclide. The results obtained are as follows. Concerning the Dt, the effect of the chelating agents for the samples of human skin was the same as for human hair. This indicates the competing effects of chelating agents against some of the reactions between metal ions in the fission products and proteins such as keratin and collagen, existing both in the skin and hair. The radioactivities, removed rapidly in the eluting solution, seem to indicate that radioactive metals in the fission products existing as ion in human tissue may have been decontaminated. The activity appearing in the eluting solution after 300 to 400 ml elution seems to indicate that the chelating agents might have acted in a competitive way on the conjugation of metal ion with protein. The decontamination percentage (Dn) for each nuclide, as given by γ-spectrum analysis, showed that ^{140}La could easily be removed, while $^{95}Zr-^{95}Nb$ could not be removed easily. (NSA of Japan)

8014 AN INVESTIGATION OF THE DECONTAMINATION OF CLOTH BY DETERGENT AND EDTA. Chen, Min-nan; Tseng, Chia-lain (National Tsing Hua Univ., Japan). Hoken Butsuri, 3: 213-22(Mar. 1968).

The decontamination of cloth by means of commercial detergent and EDTA in suitable concentrations was carefully examined. Emphasis is placed on the temperature involved during the decontamination process, the effect of the interval of depositing the contaminated cloth, and the pretreatment with starch or with a mixture of starch and EDTA before the cloth is contaminated. A conclusion is reached that the contaminated cloth can be treated more easily if pretreated with 0.3% EDTA and 1.5% starch solution. (NSA of Japan)

8015 ELIMINATION OF A FLAVOR DEFECT IN MILK TREATED FOR ^{131}I REMOVAL BY ION EXCHANGE. Stroup, W. H.; Reyes, A. L.; Read, R. B. Jr.; Dickerson, R. W. Jr.; Murthy, G. K. (Public Health Service, Cincinnati). J. Dairy Sci., 51: 1964-6(Dec. 1968).

Milk processed through a regenerated anionic resin revealed a flavor defect that required discarding the initial resin bed volumes (rbv) of treated milk. Most of this flavor defect was eliminated by removing a 1% nonionic detergent (Triton X-100) solution treatment that had been used to wash the milk residue from the resin during regeneration. The milk flow rate was increased from 0.12 to 1.0 rbv/minute to decrease additional flavor loss caused by iodine-131 removal processing. Milk was then passed through an anionic resin (Dowex 2-X8) in a chloride : phosphate : citrate cycle at 1.0 rbv/minute for five processing cycles of 175 rbv each. Between the fourth and fifth cycles, the resin was regenerated through the 2 N HCl (industrial grade) strip, then stored in pH 2 solution for one month. The flavor was acceptable on all five cycles without discarding any treated milk and without employing HCl of reagent grade to strip iodine-131 from the resin. Approximately 96% of the iodine-131 was removed from milk processed through an anionic resin at 1.0 rbv/minute for 175 volumes. (auth)

Medicine

Refer also to abstracts 7765, 7767, 7887, 7934, 7965, 8073–8079, 8081–8083, 8092, 8940, 9007, and 9279.

8016 (ACRH-29) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Mar. 1968. Contract AT(11-1)-69, 103p. Dep. CFSTI.

ANTIBODIES — production in cultured spleen cells from mice following incubation with sheep erythrocyte antigen, cell-type requirements for

DISEASES, NEOPLASTIC — carcinomas, radiotherapy of human, use of permanent chromium-51 implants for γ

DISEASES, PHYSIOLOGICAL — gout, incidence of juvenile, in man, case studies of neurological manifestations in

ELECTRON BEAMS — dosimetry in cells and organisms, effects of dose-rate on

ELECTRONS — dose to organs of human body following radiation accident, correlation of film badge readings with high-energy

HORMONES, SEX — estrogens, effects on plasma levels of cortisol- and thyroid hormone-binding globulin in man

— estrogens, effects on secretion rate of aldosterone and cortisol in man

— estrogens, effects on excretion of hydroxyproline, potassium, and sodium in urine of man

NUCLEIC ACIDS, DEOXYRIBO — size of mitochondrial, from different organisms and different tissues of same organism, constancy of

NUCLEIC ACID, RIBO — synthesis in Escherichia coli, effects of T-even bacteriophage infection on sulfur incorporation during

RADIOISOTOPE SCANNING — resolution of images from, modulation transfer function for improved

THYROID GLAND — scanning of, use of dysprosium-159 and x-ray spectrometer for fluorescent

X RADIATION — effects on hematopoietic stem cells in cultured bone marrow, effects of erythropoietin and hypoxia on

— effects on differentiation of hematopoietic stem cells in mice, effects of hypoxia-induced endogenous erythropoietin on (E.R.B.)

8017 (COO-1422-30) ESTIMATION OF BONE AND SKELETAL WEIGHT BY THE DIRECT PHOTON ABSORPTIOMETRIC METHOD. Mazess, Richard B. (Wisconsin Univ., Madison). Apr. 24, 1968. Contract AT(11-1)-1422. 23p. (CONF-680444-1). Dep. CFSTI.

From Symposium on Skeletal Mineralization, Detroit, Mich.

The direct photon absorptiometric method for radiologic measurement of bone was used to examine the intercorrelations among determinations at various sites on the human ulna, radius, humerus and femur. The relationships of local mineral content, determined by this scanning method, with the weights of individual bones and of the total skeleton was also examined. The absorptiometric method measures local mineral content with high precision and accuracy by determining the attenuation due to the mineral using a low energy photon beam from a monoenergetic radionuclide source (^{125}I) and a scintillation detector-pulse height analyzer system. Scans on the different bones were highly intercorrelated (r = 0.80 to 0.90), and correlations were even higher (=0.90 to 0.95) for different locations on the same bone. The relative uniformity of local mineral content was not sufficiently high, however, to allow specific extrapolation from single scan sites. Absorptiometric scans were also highly correlated with the weights of the bones on which they were made (? = 0.94) and even with the weights of other bones (F = 0.90) or of the total skeleton (? = 0.90). The weights of individual bones or of the entire skeleton was estimated with only a 5 to 10 percent error; scans at several sites improved the accuracy. In contrast linear measurements on the bones were only moderately correlated with local mineral content or bone

weights. Absorptiometric scanning provides not only precise and accurate measures of local mineral content, but reflects the state of the entire skeleton. The method can be used both in vitro and in vivo for assessment of skeletal status and evaluation of body composition. (auth)

8018 (COO–1732-15) NEWER CONCEPTS IN RADIOISOTOPE LUNG SCANNING. Quinn III, James L. (Chicago Wesley Memorial Hospital, Ill.). Sept. 1967. Contract AT-(11-1)-1732. 12p. Dep. CFSTI.

Radioisotope lung scanning is established as an important diagnostic tool in evaluating patients with cardiopulmonary disease. The sensitivity of the scan in detecting subtle and subclinical shifts in pulmonary artery perfusion led to some debate and confusion as to the usefulness of the perfusion lung scan in the diagnosis of pulmonary embolus. The scan should be considered an adjunctive aid in evaluating any pulmonary disease states, and should be interpreted in the light of all available clinical data and the findings on the chest roentgenogram. Perfusion and inhalation lung scans offer valuable information in the detection and localization of pulmonary emphysema. In carcinoma of the lung, the perfusion scan offers a simple method with which to assess changes in pulmonary vascular bed disproportionate to those seen on the chest roentgenogram. An important additional application of pulmonary scanning is its use in the evaluation of changes in the cardiopulmonary hemodynamics by a simple, noncatheter measurement. Lung scanning appears to offer valuable information on pulmonary perfusion changes in the normal and diseased state that is otherwise unavailable to the physician. (auth)

8019 (ORO–3796-2) NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN TISSUE (NAIL CLIPPINGS) FOR EARLY DETECTION OF CYSTIC FIBROSIS. Fite, L. E. (Texas Agricultural and Mechanical Univ., College Station. Activation Analysis Research Lab. Baylor Univ., Houston, Tex. Coll. of Medicine). Sept. 30, 1968. Contract AT(40-1)-3796. 46p. Dep. CFSTI.

Nail clippings from 713 newborn infants were analyzed for Na by activation analysis in an attempt to develop a routine procedure for the diagnosis of cystic fibrosis. The results clearly indicate the need for additional research if this method is to become reliable and efficient for the diagnosis of cystic fibrosis in newborn infants. (C.H.)

8020 (UCLA–10-P-14-X-39) APPLICATION OF THE MATHEMATICAL THEORY OF SEQUENTIAL SAMPLING TO GAMMA SCANNING IN NUCLEAR MEDICINE. Katzenstein, Henry S.; Kleinrock, Leonard; Stubberud, Allen (Solid State Radiations, Inc., Los Angeles, Calif.); Friedland, Stephen S. (University of Southern California, Los Angeles. Dept. of Medicine). [nd]. Contract AT(04-3)-627. 81p. Dep. CFSTI.

Applications of the mathematical theory of sequential sampling to radioisotope scanning with γ-emitting radioisotopes for the localization of neoplasms are discussed. It is pointed out that, while the technique of scanning has been thoroughly established in the practice of nuclear medicine, limitations have arisen with regard to the speed with which a scan can be performed and the amount of qualitative detail that can be surmised. Both speed and spacial resolution require the use of greater concentrations of the radioisotope in order to provide a maximum statistical estimate of the count rate at each point in the field, and because the aperture of the detection system must be minimized to provide the desired collimation to gain the required spacial resolution. This requirement is contrary to the desire to minimize the radiation dose to the patient. If a sufficient scanning time were allowed to establish that a low-level intensity level exists and the scanner then passed on to the next point in the field, the scan procedure would be optimized while minimizing the scan time. This procedure can be formalized in the mathematical theory of sequential sampling. In order to analyze the performance of the proposed scanning method, it is necessary to formulate a precise mathematical model of the radioactive source. Once this is accomplished, any completely defined scheme for sampling the source can be evaluated and compared to other proposed schemes on the basis of their relative performance. Mathematical models and their applications in the evaluation of scanning methods are discussed. (C.H.)

8021 (UCRL–18066, pp 58–63) CARDIAC CATHETERIZATION USING A RADIOACTIVE CATHETER AND THE SCINTILLATION CAMERA. Van Dyke, Donald C.; Anger, Hal O.; Duffy, Frederick; Higashino, Stanley; Wilson, Joyce (California Univ., Berkeley. Lawrence Radiation Lab.).

The usefulness of the labeled catheter technique for cardiac catheterization was evaluated on the basis of a limited trial in children. A scintillation camera, with a 9- to 10-in. field of view was placed beside the fluoroscope so that the patient could be viewed with either instrument simply by moving the fluoroscope table. This arrangement allowed the physician to check the position of the catheter by the standard fluoroscopic technique and to utilize fluoroscopic cineradiography. The 4-in. scintillation camera oscilloscope screen was enlarged to life size by means of closed circuit television. Radioopaque γ-emitting markers were placed in the suprasternal notch and over the xiphoid, and a 6-ft x-ray picture of the chest was taken. The magnification and orientation of the television image was adjusted by placing the x-ray picture over the television monitor so that the radioopaque markers were superimposed on the γ-emitting scintillations. Standard commercially available cardiac catheters were labeled by drying a solution of ^{141}Ce on the surface and sealing it with two coats of varnish. From 1 to 3 mCi of ^{141}Ce were applied, the amount depending on the length of the labeled region. Following initial studies in dogs and monkeys, the scintillation camera was used for evaluation of the technique in children undergoing routine cardiac catheterization for diagnostic purposes. On the basis of a limited trial, it was concluded that placement of the catheter by the new method presented no difficulty. The radiation dose received by the patient when conventional fluoroscopy was used (entry dose: 30 R) is clearly excessive. The use of image-amplification fluoroscopy reduced the dose by almost an order of magnitude to approximately 4 R/min. The use of the scintillation camera for the catheterization procedure combined with image-amplification fluoroscopy for screening and cineradiography resulted in a total dose of 1.4 R, of which 60% came from the period of fluoroscopic screening. (auth) (TSS)

8022 (UCRL–18066, pp 173–92) DELAYED RADIONECROSIS OF THE CENTRAL NERVOUS SYSTEM. McDonald, Larry W.; Lawrence, John H.; Born, James L.; Lyman, John T. (California Univ., Berkeley. Lawrence Radiation Lab.).

From a review of the literature there appears to be great individual variation in the susceptibility to the development of late radionecrosis in the central nervous system. With large fields it appears that a few percent of the population will develop late radionecrosis with single doses as low as 1500 rads to the brain or spinal cord. Both human studies and animal experimental data show that the following factors increase the likelihood of a given radiation dose producing late radionecrosis: youth; large volume of tissue irradiated; short fractionation interval; and, probably, disease involving blood vessels. Eight cases of radionecrosis are reported that were observed in patients from two to six yrs following pituitary irradiation. The lowest fractionated dose producing radionecrosis was 26 krads in 12 days. The general histology of the delayed radiation lesion following particle irradiation was similar to the lesions reported in the literature following exposure to x radiation. General features of radioinduced lesions of the central nervous system are summarized. (48 references) (auth) (TSS)

8023 (UCRL-18066, pp 193–8) HEAVY PARTICLE RADIOSURGERY IN CUSHING'S DISEASE. Linfoot, John A.; Manougian, Edward; Tobias, Cornelium A.; Born, James L.; Synder, Norton J.; Carlson, Richard A.; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Experience with radiosurgery using heavy particles for pituitary oblation in the treatment of 15 patients with Cushing's disease is summarized. Four of the patients with ACTH secreting pituitary adenomas showed a satisfactory response to treatment. Eleven additional patients were treated primarily for hypercorticism. All of the patients showed a fall in urinary steroid output and a less exaggerated response to the administration of metyrapone. The four patients who relapsed at six to 24 months showed a return of this rather characteristic abnormality. These results are interpreted as encouraging but preliminary. (auth)

8024 CHEMICAL RADIATION PROTECTION INCREASE OF THE SURVIVAL RATE OF MAMMALS BY CHEMICAL SUBSTANCES AFTER ACTION OF IONIZING RADIATION. Streffer, Christian (Univ., Freiburg i. B.). Umsch. Wiss. Tech., 68: 492-6(Aug. 1, 1968). (In German).

A review is presented of studies on the effect of chemical substances on survival of mammals after irradiation. The radiosensitivity and determination of the radiation protection in mammals are defined by the dose-effect curve and the dose reduction factor. Protective substances with sulfhydryl groups are tabulated and discussed. The use of biogenic amines and chemicals as protective substances is considered. Present assumptions on the effective mechanism of chemical radiation protectors are outlined. (J.S.R.)

8025 FIRST-AID TREATMENT IN THERMONUCLEAR INJURIES. Mitschrich, H. (Akademie des Sanitaets- und Gesund-

heitswesens der Bundeswehr, Munich). Anaesthesist, 17: 119-23(Apr. 1968). (In German).

Preliminary to a discussion of the treatment of radiation and blast injuries, the effects of atomic weapons on humans are reviewed. The damage done by radiation is of two components: the high energy radiation leads to radiation sickness if much tissue, especially of the blood-forming system, was destroyed; and thermal radiation produces burns (directly or indirectly). The different effects of tactical and intercontinental weapons are discussed. Detonation of atomic weapons in ground bursts will produce great amounts of radioactive dust, that will spread in the windward direction as fallout, causing radiation sickness as well as skin lesions by internal and external exposure. The chances of survival after populations have suffered thermonuclear weapon-induced lesions, especially through burns, radiation sickness, or a combination of both are discussed. Second to third degree burns, or radiation sickness produced by doses of more than 300 RAD, as well as the combination of both types of injury, consisting of 200 RAD plus 20% second to third degree burned body surface, must be regarded as a very severe injury under war conditions with a low survival expectancy among mass casualties. First aid, administered correctly and in time can enhance the changes of survival, especially with burn injuries predominating. (BBB)

8026 LATE LESIONS FOLLOWING THOROTRAST USE. Gaus, H.; Guelow, M.; Meyer-Hofmann, G. (Krankenhaus Nordstadt, Hanover). Klin. Wochensch., 44: 32-9(Jan. 1, 1966). (In German).

Observations of late injuries in 19 patients treated 10 to 20 yr previously with Thorotrast are described. These consisted of fibrosis and sclerosis of organs such as liver, destruction of bone marrow, and possibly the induction of leukemia. Considering that between 50,000 and 100,000 persons who were treated with Thorotrast are still living, there is considerable possibility that tumors will be induced in many of them. Probably 10 or more of these persons will develop leukemias. In the 19 patients studied no carcinomatous or sarcomatous growths were observed in the liver, spleen, or the extravascular injection area. A case of blast cell leukemia and a gall bladder carcinoma were observed in these patients. Injuries from Thorotrast increase in frequency with increasing period of deposition. (46 references). (BBB)

8027 THE INFLUENCE OF ALPHA PARTICLES FROM THE REACTION $^{10}B(n,\alpha)^7Li$ ON THE GROWTH OF TRANSPLANTED SARCOMAS. Porschen, Walter; Ritzl, Friedrich; Siebers, Guenther; Stockhausen, Wolfgang; Witt, Ingeborg (Kernforschungsanlage, Juelich, Ger.). Strahlentherapie, 135: 575-85(May 1968). (In German).

Sarcomas transplanted into mice were irradiated with thermal neutrons without or after a previous injection of ^{10}B. The neutron fluence was 3 to 4×10^{12} n/cm^2. The $^{10}B(n,\alpha)^7Li$ reaction added a dose of 600 RAD. The total dose was then 900 RAD. Irradiation with neutrons alone destroyed only a small amount of tumors smaller than 10 mm. After injection of ^{10}B followed by irradiation of neutrons, a higher cure-rate was obtained as a function of the tumor diameter. For small tumors the cure-rate was 60%, for larger tumors only 20%. The nonirradiated animals died 25 to 30 days after transplantation. The irradiation of the sarcomas after injection of ^{10}B resulted in a significant reduction of the tumor size even when no cure was obtained. The animals irradiated and cured after injection with ^{10}B reached a normal age. (auth)

8028 PROTECTION AGAINST X-IRRADIATION BY SULPHYDRYL COMPOUNDS. II. STUDIES ON THE RELATION BETWEEN CHEMICAL STRUCTURE AND PROTECTIVE ACTIVITY FOR TISSUE CULTURE CELLS. Vergroesen, A. J.; Budke, L.; Vos, O. (National Defence Research Organization TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol, 13: 77-92(1968).

The radioprotective effect of eight thiol compounds with pK-values of their thiol groups varying from 8.5 to 10.8 was tested on x-irradiated isolated cells in vitro. The influence of variations in pH of the incubation medium between 6.3 and 8.3 was investigated. The ability of the cells to form colonies was used as the criterion for survival. By comparing the protection affected by different concentrations of the various compounds it was found that a good correlation existed between the degree of radioprotection and the thiolate concentration in the medium. This correlation was also found to be present under anoxic conditions. It was concluded that the increase of the radioprotective activity of the thiol compounds, caused by an increase of either concentration, pH or temperature, can be explained by an increase of the amount of thiol compound present inside the cell. The differences in radioprotective activity of the various compounds cannot be explained by differences in cellular uptake. The thiol compounds with a pK-value lower than 10 appeared to be very toxic at concentrations between 0.1 and 2.0 mM, but not at concentrations lower than 0.1 mM and between 2 to c. 100 mM. This striking toxicity could be prevented by incubation under anoxic conditions, by a decrease of the pH to 6.3, by addition of an excess of another thiol compound or of KCN, but not by addition of $Na_2S_2O_3$. The toxic action of the thiol compounds at these concentrations seems to be caused by an irreversible intracellular reaction of a specific oxidation product of these compounds with some cellular constituent. (auth)

8029 THE THERAPEUTIC EFFECT OF A DIAGNOSTIC DOSE OF RADIOACTIVE IODINE ON THE SUBACUTE DE QUERVAIN THYROIDITIS. Varl, Bojan; Kastelic, Boris; Porenta, Miran (Univ. of Ljubljana, Yugoslava). Strahlentherapie, 136: 162-9(1968).

A report was presented on six patients with diffuse subacute thyroiditis, three patients with localized subacute thyroiditis, and two patients with subacute inflammation in the thyrotoxic nodus. In all cases the therapeutic effect of ^{131}I (30 to 50 μCi) was shown by immediate subjective relief and objective tests. To exclude the possibility of a spontaneous remission, only those patients with diffuse subacute thyroiditis in which the illness lasted more than 14 days (from 14 days to five months) and did not respond to conventional therapy were presented. All patients with diffuse subacute thyroiditis had a thyroid uptake of ^{131}I less than 6%. In one case of localized thyroiditis the accumulation of ^{131}I was diminished in the inflamed area as well as in the paranodal tissue. In the paranodal tissue the uptake of ^{131}I was diminished because of the suppression of the hypophysis by a hormonal substance from the inflamed region. (auth)

8030 DEPTH DOSE CALCULATIONS FOR ^{60}Co APPLICATORS FOR EYES BY STALLARD (CKA 5 TO 11). Magnus, Lothar; Goebbeler, Theodor; Stroetges, Wilhelm (Ruhr-Univ., Bochum, Ger.). Strahlentherapie, 136: 170-7(1968). (In German).

Equations were given for ^{60}Co-applicators for eyes by Stallard (CKA 5 to 11), that gave the radiation dose per time at different tissue depths. The results were tabulated. The values calculated permitted an exact dose determination for every tumor depth. (auth)

8031 EFFECT OF PROTECTIVE AGENTS ATTENUATING RADIATION SEQUELAE AND OF THE BONE MARROW INTRODUCTION ON THE STATE OF IRRADIATED ANIMALS. Izvekova, A. V.; Tumanyan, M. A. (Inst. of Epidemiology and Microbiology, Moscow). Med. Radiol., 10: No. 13, 41-5(1968). (In Russian).

Data are reported on the effect of protective agents (1-cysteine and polysaccharide derived from the bacterium Eberthella typhosa) used in combination with chemotherapy and administration of bone marrow on the body weight, leukocyte level, and ESR in mice, rats, and rabbits exposed to lethal doses of x radiation. The experiments demonstrated that the body weight of the exposed and then treated animals was much less reduced than that of the control animals (exposed but not treated). In two weeks after exposure all the treated animals tended to regain weight. Leukopenia in the exposed and treated animals was not significant as in control animals. Leukopoiesis began to redress in the treated animals much earlier than in the controls. The ESR remained normal throughout the entire period of observation. The survival rate of the animals exposed to a lethal dose and subsequently protected and treated attested to the high efficiency of the combined method. (auth)

8032 DISTRIBUTION OF THE RADON DAUGHTER PRODUCTS SUBSEQUENT TO RADON PROCEDURES AND ITS EFFECT ON THE IRRADIATION OF ORGANS AND TISSUES. Andreev, S. V. (Central Scientific-Research Inst. of Physical Therapy, Moscow). Med. Radiol., 10: No. 13, 31-7(1968). (In Russian).

A quantitative evaluation was made of the redistribution in an organism of the daughter products of radon used in three forms of radiotherapy. This permitted the bringing out of the irregularities attendant to irradiation of organs and tissues as dependent on conditions under which organisms were exposed to irradiation. (auth) (TSS)

8033 RADIOSENSITIVITY OF ESCHERICHIA COLI 15T$^-$ AND THE METABOLIC EFFECT OF CYSTEINE. Nagy, Zs.; Hernadi, F.; Kovacs, P.; Valyi-Nagy, T. (Univ., Debrecen, Hungary). Radiat. Res., 35: 652-60(1968).

The addition of cysteine to exponentially growing cultures of Escherichia coli 15T$^-$ inhibited their growth. Under such circumstances the x-radiosensitivity of bacteria decreased. The addition of cysteine resulted in an arrest of RNA, but not DNA, synthesis; further, the free SH content of the cells was enhanced. It was suggested that a correlation existed between the metabolic

(toxic) effect of cysteine and its action, reducing radiosensitivity. (auth)

8034 INTERNAL RADIOTHERAPY OF EPIDERMOID CARCINOMA ON THE INNER SIDE OF THE CHEEK. Pierquin, B.; Chassagne, D.; Quint, R. (Institut Gustave Roussy, Villejuif, France). Ann. Otol., Rhinol., Laryngol., 84: 403-8 (June 1967). (In French).

The use and effects of Ra and ^{192}Ir in cancer therapy of the soft portion of the cheek were studied. Tumors were classified into four categories. A survey of 35 cases treated from 1949 to 1964 was made with 23 cases treated by Ra (1949 to 60) and 12 cases by ^{192}Ir. In the cases with primary tumors, the directions of needle implants were parallel to the oral mucous membrane and the skin surface. Isodose contours for cheek radioimplants are shown. In each series, the total dose to the tumor was about 7500 rad. In cases with adenopathy, surgery was used followed by a single dose of 6000 rad of telecobalt. Over a period of 2.5 yr survival was about 50%. (BBB)

8035 TUBEROUS ORBITAL CONJUNCTIVAL ANGIOMA OF THE SKIN. ELECTROCOAGULATION, BETA THERAPY WITH ^{90}Sr AND LASER PHOTOCOAGULATION. Olteanu, M.; Boeras, F.; Ciurea, V.; Guta, Al.; Petre, M. Rev. Sanit. Mil., 61: 65-7 (Jan.-Feb. 1968). (In Rumanian).

A case of a patient aged 30, treated at first surgically, then with ^{90}Sr irradiation, then with laser photocoagulation, with good ultimate results is reported. (JPRS)

8036 A NEW OPERATION-RADIOTHERAPY COMBINATION FOR TREATMENT OF CARCINOMA OF THE CERVIX UTERI. Nieminen, Usko (Univ. Central Hospital, Helsinki). Acta Obstet. Gynecol. Scand., 47: 52-7 (1968).

External radiotherapy administered routinely following the extended Wertheim operation often resulted in damage to the tissues and prolonged after-effects (dysuria, diarrhea, melena, pain due to intestinal spasm, and dermatitis). The complications were less severe with pendulum x ray and high-energy therapy than with the older x-ray methods, but the intrapelvic treatment area was often difficult to localize, especially in obese patients. Even when the area was pinpointed, a small change in the patient's position resulted in the irradiation failing to reach the target area. The use of a new automatic applicator unit and technique for intracavitary radiotherapy, to reduce such errors and prevent severe sequelae to irradiation, during extended Wertheim operation was described. The device incorporated a spherical lead container mounted on bearings on a support. When not in use, the isotope was shielded inside the container. The path of the isotope followed a tube which could be bent to the desired shape and which facilitated insertion of the sound into the patient. The isotope was moved from the container to the sound and back electrically. It was attached to the end of a flexible tube furnished with special toothing. The shaft moved when the toothing was engaged by a cog-wheel gear driven by an electric motor which could be started by remote control, e.g., from outside the treatment room. The time spent by the isotope in the sound was governed by a preset therapy timer. When the treatment time was reached, the isotope returned automatically into the container. The location of the isotope was indicated by two signal lights of different color, one for the sound and the other for the container. Contact therapy with ^{137}Cs was administered in the final stages of extended Wertheim's operation before peritonealization of the operative area. The sound of the applicator was placed in the area between the stump of the vagina and the lateral wall of the pelvis, i.e., in an area to which postoperative external radiotherapy would be administered. To protect the ureters a metal shield which absorbs 75% of the radiation was placed between the tip of the sound and the ureter. In addition, the ureter was pushed as far from the radiation source as possible. During 10 to 20 min the region of both parametria received 500 to 1000 rad, or a total dose of 1000 to 2000 rad. (BBB)

8037 LASER IN OPHTHALMOLOGY. Vallotton, William W. (Medical Coll. of South Carolina, Charleston). J. S. C. Med. Ass., 64: 1-3 (Jan. 1968).

The laser and its uses in ophthalmology are described. The light from the ruby laser has the characteristics of collimation or bundling, lacks divergence, is monochromatic, is about 10,000 times brighter than the light of the sun, can be focused, diverged or converged with lenses, and its energy potential could be controlled by variations of power input, ruby size, cooling, etc. The ruby is stimulated by a Xe photoflash tube to emit the laser beam. After the beam leaves the ruby, it passes through an afocal lens system. The operator's eye is protected from bounce-back reflection from the patient's eye by a filter that slides into place the moment before the laser is fired. The time it takes for the laser beam to be generated in the ruby rod and focussed into the eye is about 0.0007 sec and it has a very low power of about 0.75 J. The laser photocoagulator is dangerous because the collimated light may be reflected many times and yet still retain sufficient energy to produce retinal burns in the eyes of bystanders. Observers of laser photocoagulations in the laser room should wear special laser-proof shades. The most significant use of laser light is in the repair of retinal holes and tears. The areas having retinal breaks are sealed off, and then laser photocoagulation may be applied to the choroid and retina around the break, and a fluid-tight chorioretinal adhesion obtained. Laser photocoagulation can be done in as little as five min without anesthesia of any sort. Since the beam emitted from the ruby laser is monochromatically red, retinal blood vessels are more or less immune to the laser energy. Ruby laser light cannot be used effectively in the treatment of diabetic microaneurysms or other blood vessel tumors of the eye because of monochromaticity. (BBB)

8038 RADIOACTIVE TANTALUM IN THE TREATMENT OF CARCINOMA OF THE BLADDER. Pedersen, Flemming Brix; Poll, Paul (Bispebjerg Hospital, Copenhagen). Scand. J. Urol. Nephrol., 1: 29-33 (1967).

The effects and side-effects of interstitial irradiation with ^{182}Ta needles in 62 patients with bladder tumors are reported. The β radiation was filtered with a layer of platinum and the period of irradiation for the required dose (around 6000 R) was between 5 and 8 days, depending on the age of the wire. Four patients showed severe reactions, but the remaining patients had only slight or negligible symptoms. In the first group, 2 of the patients required cystectomy and 1 was treated with ureterosigmoidostomy. At cystoscopy, severe radionecrosis was seen at the tumor site. Sigmoid perforation with resultant peritonitis developed in one case. Frequently the subjective discomfort was not correlated with cystoscopic changes. Thus, one patient who at no time had any micturition difficulties was found 9 months after treatment to have pronounced radionecrosis at the site of implantation. As a rule, about 6 months after the operation there was a white, flat, reactionless scar, surrounded by a zone of telangiectasia. (BBB) (TSS)

8039 USE OF THE DTPA AEROSOL (DIETHYLENE TRIAMINE PENTAACETIC ACID) FOR PROPHYLAXIS OF RATS CHRONICALLY INHALING ^{239}Pu. Lyubchanskii, E. R.; Koshurnikova, N. A. Med. Radiol., 10: No. 13, 46-52(1968). (In Russian).

Experiments were conducted with 77 rats inhaling the citrate complex of ^{239}Pu for 10, 20, and 80 days (for 10 minutes three times a week). It was found that prophylactic inhalation of $CaNa_3$ DTPA prior to administration of ^{239}Pu (the total complex dose 0.75 to 5.25 mg) reduced the level of the emitter in the organs of the treated animals five to tenfold. Preliminary administration of the DTPA aerosols did not essentially affect the pattern of macroscopic and microscopic distribution of plutonium, and the kinetics of its excretion from the organs (as compared with untreated animals). Prophylactic inhalation of DTPA might prevent development of severe pneumosclerosis and changes in other organs. (auth)

8040 ON THE TREATMENT OF SKIN INJURIES CAUSED BY IONIZING RADIATIONS (REVIEW OF THE LITERATURE). Ilin, B. I. Vestn. Dermatol. Venerol., 39: 42-7 (Aug. 1965). (In Russian).

Results of 56 articles are reviewed and in addition, a 3-point classification of radioinduced skin injuries is provided as follows: 1st stage—early, local, superficial reaction with erythema; 2nd stage—a latent one that passes without visible changes, but the irradiated areas may undergo hypo- or hyperthermia and cellular changes; 3rd stage—severe inflammation and the climatic period during which four subreactions may appear. These include epilation resulting from soft x-ray doses beginning at 375 to 450 R, or β-ray doses up to 1500 rep; erythema resulting from x-ray doses of 450 to 600 R or more, or β-ray doses of 1500 to 3000 rep; bullous formation, in the sore, swollen skin, resulting in blisters that soon break and suppurate, after a single x-ray dose of 800 to 1200 R or more, or β-ray doses of 3000 to 10,000 rep; and ulcerous-necrotic changes, resulting from a single high-dosage irradiation and appearing as ulcers. In early stages of skin injury the patient may be given an infusion of glucose or drugs such as dimedrol, ergotamine, or prednisolone. The 2nd stage may require sedation for the ensuing reactions and administration of antihistamine and desensitizing agents, vitamins, antiinflammatory lotions, and vegetable oils. If erythema and swelling continue to develop, blocking their painful sequelae with Novocaine is suggested. The 3rd stage is accompanied by discomfort and restlessness. In the initial blister stage the treatment may be the same as for stage two, with sterile emollients. Vitamins may also be helpful. To prevent infection, the base of skin ulcers should be cleansed of all necrotic debris, and the granulation tissue stimulated with various emulsions. (BBB) (TSS)

8041 RESEARCH ON THE RADIOPROTECTIVE ACTION OF CYSTEAMINE ON TISSUES CULTURED IN VITRO. Lullini Galliani, I. (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 42: 1587-9(Nov. 30, 1966). (In Italian).

Chicken fibroblasts and myoblasts in tissue cultures were treated with cysteamine 15 to 20 min before irradiation with 50-KV x rays. After irradiation the cells were fixed and stained, and the number of mitoses counted per mm^2. The cultures were fixed two, three, six, and 24 hr after irradiation with doses of 1000 to 2000 R. No radioprotective effect of cysteamine (added at a level of 0.01%) was seen in the two hr samples treated with 1000 R. The number of mitoses/mm^2 was 30.87 in controls, 29.39 in irradiated cultures, and 20.38 in cysteamine-treated irradiated cultures. In the six hr 1000 R samples a slight but insignificant protective effect was noted, the respective values being 26.74, 23.10, and 28.23. At all other sampling times and doses, no protective effect was evident; in fact, a radiosensitizing action of cysteamine was noted. For example, the values for control, irradiated, and cysteamine-treated irradiated cultures for 24 hr, 1000 R samples were 31.90, 23.23, and 4.64; for 24 hr, 2000 R, 0.005% cysteamine 11.46, 2.76, and 1.23; 24 hr, 2000 R, 0.0025% cysteamine 38.51, 22.90, and 10.65. Abnormal mitoses, pyknosis, and cytolysis were particularly evident in the cysteamine pretreated cultures. (BBB)

8042 COMPARATIVE RESULTS OF ORTHOVOLTAGE AND SUPERVOLTAGE IN THE TREATMENT OF UTERINE CERVICAL CARCINOMA. Bosch, Antonio; Valencia, Arturo; Marcial, Victor A. (Centro Nuclear de Puerto Rico, San Juan). Radiologia (Panama), 18: 7-13(Dec. 1967). (In Spanish).

Complications encountered in the treatment of 545 cases of cervical cancer with 250-kV x rays or ^{60}Co γ radiation and/or intracavitary Ra or ^{60}Co implants are reported. A tumor dose of 4000 R over six weeks with x rays was given or 4500 R over six weeks with ^{60}Co external irradiation. Intracavitary irradiation delivered about 4000 R of γ radiation to Point A. The five yr survival rate was higher for all four stages of cervical cancer with supervoltage as compared with orthovoltage irradiation. Complications were more frequent with orthovoltage (3%) than with supervoltage (2%) irradiation. The number of complications with orthovoltage (total of 406 patients) and supervoltage (130) irradiation, respectively, were: cystitis seven, none; vesicovaginal fistula three, one; rectovaginal fistula one, one; rectal stenosis one, none; proctitis one, none; and intestinal obstruction none, one. Thus a total of 16 patients out of the 545 irradiated developed these complications. (BBB)

8043 EFFECT OF BLOOD LOSSES IN MASTECTOMY ON PATIENTS' TOLERANCE OF RADIATION AND CHEMOTHERAPY. Shnittser, Yu. M. (Regional Oncological Dispensary, Lvov). Vop. Onkol., 14: No. 10, 21-5(1968). (In Russian).

The amount of blood loss in radical mastectomy determined by gravimetric methods ranged from 220 to 1380 ml, the average being 652 ml. It is suggested that the amount of blood loss depends on the volume of the blood supply to the mammary gland. The degree of postoperative anemia and resistance of the patient are determined by the amount of blood loss during surgery. It is not feasible to use postoperative irradiation or chemotherapy in cases of extreme blood loss. (H.L.W.)

8044 ISOTOPE PLACENTOGRAPHY. Hernady, T.; Neubauer, G. (Univ., Budapest). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 494-8(Oct. 1968). (In German).

Indications for isotope placentography are reviewed. A comparison of the biological and physical requirements indicate that at present an erythrocyte suspension marked with ^{51}Cr is a suitable material, although this has no great advantage over radioiodine marked serum albumen. The simplest method for marking erythrocytes with ^{51}Cr and methods of measuring activity are described. (auth)

8045 TIME-DOSE RELATIONSHIPS IN RADIOTHERAPY. Caldwell, William L. (Vanderbilt Univ., Nashville). J. Tenn. Med. Ass., 60: 834-5(Aug. 1967).

The innovation of new methods of radiotherapy resulted in improvement in the local control of tumors without an appreciable increase in reactions in adjacent normal tissues. Normal tissues tolerated well treatment with 3000 R in two weeks, three weeks rest, and another 3000 R in two weeks. Treatment three times a week instead of the more usual five times a week was in most instances well tolerated. If treatment was given over the same overall time period, then because of a smaller number of fractions of radiation, the dose was ordinarily reduced by approximately 10%. Patients with Stage T1 or T2 carcinomas of the bladder were treated by three dose schedules. All patients, randomly categorized as to dose schedule, were treated with a three-field technique with moderate sized fields to a total dose of 6500 R. One group was treated with increments of 200 R/treatment, another with 250 R/treatment, all patients being treated five times a week. There was an increased incidence of gastrointestinal complications in the group treated with the 300 R fractions, but in most instances the reactions were reversible; one patient required a permanent colostomy. (BBB)

8046 USE OF COMPENSATING CLINOID FILTERS IN IRRADIATION OF INCLINED SURFACES. Lun, K. K. (Daugavpilsk Oncological Hospital, Riga). Vestn. Rentgenol. Radiol., No. 5, 70-1(Sept.-Oct. 1968). (In Russian).

A survey of the existing methods of correction in irradiation of inclined surfaces is presented. In distance gamma-therapy with source-skin distance equal to 75 cm the isodose is deviated to an angle equal to ⅓ of the irradiation angle of the surface. The author describes a set of compensating clinoid filters in irradiation at an angle on a distance gamma-therapeutic unit. (auth)

8047 PROTECTIVE ACTION OF PHENYLALANINE DURING THE IRRADIATION OF AQUEOUS BIOPOLYMER SOLUTIONS. Brodskaya, G. A.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow. Inst. of Nuclear Physics, Tashkent). Khim. Vys. Energ., 2: 184-5(Mar.-Apr. 1968). (In Russian).

During the irradiation of mixtures containing aromatic and nonaromatic compounds energy transfer may take place between the components of the system, whereby the nonaromatic compounds have been known to act as acceptors for radicals and ions. The mechanism of the protective activity was examined, using phenylalanine, the best radiation-resisting aromatic amino acid, in aqueous nucleic acid and protein solutions. The study involved the determination of ammonia formed by the radiolysis of DNA, RNA, guanosine, cottonseed albumin, and glycine solutions, without and with 0.001, 0.0001 and 0.002 mole/l of phenylalanine exposed at 37°C to a 400 RAD/sec of a ^{60}Co source. The results confirmed the protective action of phenylalanine, increasing with the concentration of the compound. Similar behavior was also observed with dry specimens. The ability of phenylalanine to act as an acceptor is attributed to either the joint action of acceptor groups, resulting in the removal of H and OH and recombining them to water, or to the further decomposition of the phenylalanine molecule formed during the hydrolysis of glycine. Thus, the protective action is due to the competition between the aromatic amino acid and the biological system for the products of the radiolysis of water. (TTT)

8048 MODIFICATION OF RADIATION RESPONSE IN SYNCHRONIZED HeLa CELLS BY METABOLIC INHIBITORS. I. EFFECT OF AN INHIBITOR OF RNA-SYNTHESIS, PUROMYCIN AMINONUCLEOSIDE. Djordjevic, B.; Kim, J. H.; Kim, S. H. (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Radiat. Biol., 14: 1-7(1968).

Treatment of irradiated HeLa cells with puromycin aminonucleoside (PAN), an inhibitor of ribosomal RNA-synthesis, markedly reduced colony-forming ability. Post-irradiation treatment with PAN in the mitotically synchronized cells showed that the highest potentiating effect of PAN was observed at the end of the S phase, normally the most radioresistant part of the cell cycle, and least effective during G−2 and G−1 phases, in that order. Based on the known mechanism of action of this drug, the possible role of certain metabolic events in radiation response of living cells is discussed. (auth)

8049 STUDIES OF PULMONARY FUNCTION AND REGIONAL BLOOD FLOW USING ^{133}Xe. Loken, Merle K. (Univ. of Minnesota, Minneapolis). Lahey Clin. Found. Bull., 16: 337-43 (1967).

The short biological half-life of ^{133}Xe permitted studies to be performed and repeated if necessary without excessive radiation hazard to patients. These included pulmonary function and blood flow, cerebral blood flow, coronary blood flow, and peripheral blood flow. For evaluating pulmonary function and regional blood flow, ^{133}Xe was a versatile radioisotope. Irradiation hazard was low provided that the Xe was quickly exhausted from the room. Measurements of the pulmonary function and blood flow were discussed. Computer techniques permitted data to be obtained on regional pulmonary function as well as regional blood flow to the lungs and brain. (BBB)

8050 LINEAR ACCELERATOR SUPERVOLTAGE RADIATION THERAPY: TESTICULAR TUMORS. Earle, John D.; Bagshaw, Malcolm A.; Kaplan, Henry S. (Stanford Univ. Medical Center, Palo Alto, Calif.). Radiology, 91: 1008-12; 1025(Nov. 1968).

One hundred and forty-six patients with testicular tumor were treated at Stanford Medical Center Division of Radiotherapy since 1956. The survival rate (actuarial) of 69 with seminoma was nearly 95 percent; of 49 with carcinoma was 40 to 45 percent, although 75

percent survival was obtained in the Stage I cases. A small group of patients were given radiotherapy interrupted by retroperitoneal lymph node dissection; in these it was possible to correlate the surgical staging with the lymphangiographic. In seminoma, a combination of orchiectomy and radiotherapy as the management of choice was confirmed. A number of studies of testicular carcinoma gave no evidence that vigorous modern radiotherapeutic technics with megavoltage equipment can be surpassed. There was some indication that radiotherapy alone was the treatment of choice. (auth)

Radiation Effects on Animals

Refer also to abstract 7943.

8051 DEISTVIE ULTRA-FIOLETOVOI RADIATSII NA KLETKU. (Effects of Ultraviolet Radiation on Cells). Samoilova, K. A. Moscow, Izdatel'stvo Nauka, 1967. 144p.

The lethal, antimitotic, and stimulating effects of uv radiation on cells and the principal factors determining radiosensitivity are discussed. Data on uv effects on cell structure and metabolism are given and are analyzed in terms of molecular concepts. (C.O.)

Invertebrates

Refer also to abstract 7973.

8052 FURTHER NOTES ON THE STRONTIUM CONTENTS OF UNALTERED FOSSIL CEPHALOPOD SHELLS. Hallam, A. (Univ. of Edinburgh); Price, N. B. Geol. Mag., 105: 52-5(Jan.-Feb. 1968).

Earlier studies indicated that a systematic decrease in Sr/Ca ratio in certain well-preserved gastropod shells, from the Carboniferous to the present, was the result of biochemical evolution involving increasing powers of discrimination against Sr in sea water. Support for this interpretation was sought by examining nautiloid material of ages between the Carboniferous and the present. Results clearly showed a systematic decrease in the Sr/Ca ratio from the Carboniferous to the present. This signifies a gradual biochemical evolution of nautiloids, in respect to diminishing Sr content of the shell, that accelerated in Tertiary time to reach a level almost identical to the mean value of a large number of Mesozoic ammonites. This may relate to a progressive improvement in the efficiency of the circulatory system, as suggested in the exchange theory of Odum. (BBB) (TSS)

8053 ELECTRONIC COMPUTERS AND SURVIVAL-CURVE ANALYSIS. Wuergler, F. E. (Swiss Federal Inst. of Tech., Zurich). Int. J. Radiat. Biol., 14: 193-6(1968).

Computer programs were developed for the analysis of survival data obtained by irradiation of Drosophila eggs and embryos. Mathematical equations are given to represent models based on the shape of the survival curve in a semilogarithmic plot of the experimental data. Fortran programs were written for fitting models to the data. The structure of the card deck for the input data is described. The output data contain the dose, calculated survival, experimental survival, calculated mortality, experimental mortality, square of deviation, and calculated weight. (H.L.W.)

Vertebrates

Refer also to abstracts 7929, 7934, 7935, 7937, 7938, 7942, 7946, 7947, 7950, 7957, 7958, 7961, 7970, 7971, 7975, 7982, 8009, 8016, 8022, 8024, 8027, 8028, 8031, 8039–8041, and 8095.

8054 (AD-671054) EARLY ALVEOLAR CELL MITOTIC ACTIVITY AND PULMONARY TUMOR INCIDENCE IN URETHAN TREATED X-IRRADIATED MICE. Birdwell, Thomas R.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 12, 1968. 17p. (USNRDL-TR-68-51). CFSTI.

Groups of young adult LAF1 mice received a single intraperitoneal injection of urethan (1 mg/g body weight) given either alone, before (1 or 7 days) or after (7 days) a 300 R whole body dose of x radiation. The effects of these treatments on alveolar cell mitotic activity during the subsequent 15 days, and on pulmonary tumor incident at 13 to 24 weeks were determined. The mice receiving urethan only, all showed lung tumors at 24 weeks. The groups irradiated prior to or after urethan injection showed significant decreases in the number of tumors per mouse, as well as a decrease in mitotic activity 15 days posttreatment. The suppression in both these parameters was more pronounced when x radiation preceded urethan treatment by 1 week, than when it was administrated 1 week after urethan. The results indicate that at this moderate dose of x radiation (300 R) there is an inhibitory effect on urethan lung tumorigenesis. It is suggested that x irradiated alveolar cells under these experimental conditions are relatively resistant to the effects of urethan, as reflected both in mitotic activity, and in subsequent tumor production. The theoretical bases for these observations on lung tumorigenesis are briefly discussed. (TAB)

8055 (UCRL-18066, pp 151-65) MEASUREMENT OF THE EFFECTS OF X RAYS AND HELIUM IONS ON THE PROLIFERATIVE CAPACITY OF LYMPHOMA ASCITES TUMOR CELLS IN VIVO. Feola, Jose M.; Lawrence John H.; Welch, Graeme P. (California Univ., Berkeley. Lawrence Radiation Lab.).

The oxygen enhancement ratio (OER) and the relative biological effectiveness (RBE) of 910 MeV helium ions of various linear energy transfer (LET) were compared using the growth of transplanted ascites tumor cells in mice following x irradiation in vitro as the test criteria. Seven days prior to irradiation, mice were injected with tumor cells. Thirty minutes before irradiation the animals were sacrificed and tumor cells in ascitic fluid were removed and irradiated in an atmosphere of either oxygen or nitrogen. A counted number of tumor cells was then injected into mice and the number of tumors that developed during the next eight wks was recorded. Results are presented in graphs and tables and the value of the experimental procedure for measuring the net result of a number of radiation-initiated processes in cells is discussed. (C.H.)

8056 MODIFICATIONS OF THE RAT BRAIN INDUCED BY LOCALIZED BETA RADIATION DURING ONTOGENESIS. Pulliam, James Augustus. Rochester, N. Y., Univ. of Rochester, 1967. 236p.

Thesis.

Methods for using localized β radiation to modify the ontogenesis of the rat brain were evaluated. Normal developmental processes unveiled by their continuation in tissue neighboring the lesion in which radiation had either arrested or greatly reduced development were analyzed. A 600-mc $^{90}Sr-^{90}Y$ radiation source, used with shields having apertures 3 by 1 mm in area, 2 mm in diameter, or 0.75 mm in diameter, permitted irradiation of selected regions of the cerebrum, midbrain, or cerebellum, in rats ranging in age from the sixteenth fetal day (6 days prepartum) to the sixth postnatal day. Ninety-six fetal rats and 156 neonatal rats were irradiated and studied along with over 100 littermate controls. Prenatal irradiation of the brain through the uterine wall did not interfere with normal delivery, and the mother rats which had been subjected to surgery for the irradiation of their fetuses usually provided their young with normal maternal care. Head deformities and epilation at the site of irradiation made identification of the irradiated rats simple. The growth and the behavior of the prenatally and postnatally irradiated rats were observed until they were one-month-old, at which time they, along with their littermate controls, were euthanized and their brains removed. The gross anatomy and the internal structure of all brains were studied, and some brains were selected for histological analysis. The effect of radiation on the brain depended upon the age of the rat at the time of irradiation, the brain region, the radiation geometry, and the dose. Accordingly, appropriate manipulation of these variables produced any one of the following conditions: discrete lesions in one or two cerebral (Brodman's) areas, complete necrosis of a cerebral lobe or hemisphere, unilateral cerebral hypoplasia, necrosis or hypoplasia of the corpora quadrigemina, or hypoplasia of a single cerebellar hemisphere, of the vermis, or of the entire cerebellum along with abnormally oriented folia in prenatally irradiated rats. Functional disorders occurred only in rats having cerebellar damage, and in them the severity of the disorders was proportional to the degree of cerebellar hypoplasia, and the nature of the disorder was dependent upon the locus of cerebellar injury. Varying degrees of tremors and motor incoordination occurred in rats having hypoplasia of most of the cerebellum, whereas swaying was found in a rat in which prenatal irradiation had caused severe vermian hypoplasia, and head wagging occurred in a rat in which hypoplasia of the hemispheres had left the vermis disproportionately large. The β radiation dose required for complete elimination of a given type of neurons increased with age. Whenever prenatal irradiation reduced the size and the growth rate of one cerebral hemisphere, the cortical tissue from the other hemisphere migrated across the midline (displacing the interhemispheric fissure), and this migration increased the area and reduced the thickness of the cortex of the uninjured hemisphere. It was postulated that in normal development the two cerebral hemispheres partially govern the morphogenesis of each other by limiting the migration of the cortical tissue in the median direction. The β radiation lesions were discrete enough to yield data on regional radiosensitivity and on the role of a selected brain region in ontogenesis. (Disser. Abstr.)

8057 EFFECTIVENESS OF ANTICONVULSANTS IN MICE EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS. Davis, Lawrence W.; Strike, Thomas A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res., 36: 344-51(1968).

The effectiveness of four anticonvulsants was tested in male CF_1 mice exposed to 500-, 1000-, and 10,000-RAD doses of mixed γ-neutron radiations. Prevention of the hind leg extensor component of a maximal convulsion induced by electroshock was selected as the end point for effective anticonvulsant activity of diphenylhydantoin, phenobarbital, and mephenytoin. Prevention of convulsions induced by pentylenetetrazol was the end point of effective anticonvulsant activity of trimethadione. The effectiveness of the drugs was evaluated by comparing the ED_{50}'s to the ED_{50} value for unirradiated controls. The anticonvulsants tested by electroshock showed a tendency toward increasing effectiveness after 500- and 1000-RAD doses of radiation and a significantly increased effectiveness following 10,000 RADs. Trimethadione effectiveness in irradiated mice was similar to that in unirradiated controls at all doses and times tested. (auth)

8058 INVESTIGATIONS ON THE NUCLEIC ACID CONTENT IN THE BRAIN OF NEONATAL RATS X-RAY IRRADIATED AT DIFFERENT PERIODS OF THE FETAL LIFE. I. CYTOPHOTOMETRIC DETERMINATION OF THE DNA CONTENT IN NEUROCYTES. Mularek, Olga (Medical Academy, Poznan, Poland). Exp. Pathol., 2: 78-86(1968).

Microscopic and macroscopic studies showed that irradiation of the pregnant female rat produced different developmental defects of the brain in the neonatal rat if the irradiation took place on the 9.5 and 18.5 day of pregnancy. Irradiation on the 6.5 day did not lead to any identifiable changes. The most significant defects and a twofold decrease in the number of newborn animals in one delivery was noted for the group irradiated on the 9.5 day. This time coincided with the critical period of development of the central nervous system. A dose of 250 R caused almost 100% fetal necrosis and resorption. Among the developmental malformations noted were anencephalia, anophthalia, internal hydrocephalus, and hypoplasia of the cerebral hemispheres, cornu ammonis, and corpus callosum. There were also defects in the cortical cytoarchitecture, as well as many necrotic foci in the brain. The most pronounced variation in DNA content was found in the Purkinje cells of the animals irradiated on Day 18.5 of pregnancy. Most Purkinje cells nuclei contained a DNA quantity characteristic for hyperdiploid forms. In the control group most Purkinje cell nuclei had a content of DNA characteristic for hyperdiploids. The DNA content in the hippocampus cell nuclei and in the cerebral cortex cells nuclei was approximately equal to those of the control group. (BBB)

8059 PHYSICAL DOSE AND BIOLOGICAL EFFECT OF IONIZING RADIATIONS. Krokowski, E. (Freie Univ., Berlin). Roentgenpraxis, 18: 75-82(1965). (In German).

Equipment and procedures used for definition and measurements of radiation dose are described, and relations between dose and somatic or genetic irradition injuries are outlined. Compared to a value of one for x rays, γ rays, electrons or β radiation, the RBE of fast neutrons, protons with energies up to 10 MeV, and α rays is 10, and for heavy nuclei 20. Dose-effect relations are exemplified in terms of x irradiation of the eye lens in animals. Dose-reaction time curves are illustrated for periods of up to 12 months postirradiation time. The LET values for x irradiation up to 1000 kv, Ra and ^{60}Co irradiation, 20- to 31-MeV electrons, neutrons, α radiation, heavy nuclei, and fission products are tabulated. The relation between LET and RBE is illustrated, and responses of various organisms, tissues, and animals to various types and amounts of irradiation are tabulated for RBE. Practical conclusions from the material relating to evaluation of RBE of irradiation are presented. (BBB) (TSS)

8060 COMBINED SURGICAL AND RADIATION INJURY: THE EFFECT OF TIMING OF WOUNDING AND WHOLE-BODY GAMMA IRRADIATION ON 30-DAY MORTALITY AND RATE OF WOUND CONTRACTURE IN THE RODENT. Stromberg, L. W. R.; Woodward, K. T.; Mahin, D. T.; Donati, R. M. (Walter Reed Army Inst. of Research, Washington, D. C.). Ann. Surg., 167: 18-22(Jan. 1968).

Rats were wounded four days before, one day before, one day after, or four days after irradiation. Irradiated animals were exposed to a midline air dose of 875 R of ^{60}Co γ radiation at a dose rate of 67.3 R/min. Timing of the irradiation and the wounding had an effect upon mortality. Wounding alone produced no deaths, but irradiation alone resulted in eight deaths among 18 animals, i.e., a 57% survival. Wounding one day prior to irradiation decreased mortality to four of 18, a 78% survival rate; whereas wounding four days after irradiation resulted in 14 deaths of 18, a 22% survival rate. Wounding at other times was not associated with alteration in survival rates from that of animals that were irradiated only. The timing of irradiation and wounding had a profound effect upon the rates of closure. Wound measurements of nonirradiated animals showed a lag period of about four days followed by rapid closure so that the wounds were contracted to 25% of the initial area by the 14th day. In animals irradiated after wounding, short-term cessation of wound closure was observed. This followed an initial lag period similar to that of controls. Subsequently, closure was interrupted by a transient cessation of contracture lasting about two days. Severe bone marrow depression which follows irradiation may be associated with depression of fibroblastic function. Such a defect could result in a delay in adherence of a wound edge to the granulation tissue bed. (BBB)

8061 EFFECT OF TOTAL-BODY IRRADIATION ON MURINE ERYTHROPOIESIS. Brady, Luther W.; Lisi, Louise; Brodsky, Isadore; Ruggieri, Susanna T.; Fortune, Henry (Hahnemann Medical Coll., Philadelphia). Radiology, 91: 703-7(Oct. 1968).

Female mice received a whole-body dose of 150 rads x radiation, following which erythropoiesis was studied at days one, two, three, seven, fourteen, and twenty-two. Hematologic parameters were evaluated along with controls at each time interval. These included hemoglobin, hematocrit, plasma ^{59}Fe clearance, ^{59}Fe reappearance within the red cell, plasma iron turnover rates, and liver, spleen, and carcass ^{59}Fe localization. The data indicate that the initial effect of low dose (150 rads) whole-body irradiation on erythropoiesis is the development of ineffective release of maturing red blood cells from the bone marrow as demonstrated by the sharp decrease in the ^{59}Fe reappearance. (auth)

8062 EFFECT OF ^{32}P ON THE SURVIVAL OF SPERMATOGONIA AND OOCYTES IN MICE. Reddi, O. S. (Osmania Univ., Hyderabad, India). Nature (London), 219: 1389-91(Sept. 28, 1968).

It has been shown that very low doses of x rays, gamma rays, or fast neutrons greatly reduce the population of late type A, intermediate and type B spermatogonia in mice, and a cellular system has been demonstrated in oocytes which prevents repair of radiation damage. The present communication describes some studies with internally administered ^{32}P, employing mice. Data are tabulated for survival fractions of type A and B spermatogonia and resting primary spermatocytes (RPS), and for stage I and II oocytes. The sensitivity spectrum showed a marked variation between the cell types when given different doses. Stage II oocytes were more sensitive than stage I at doses >3 μCi. The results clearly indicate a multi-hit process, and the differential sensitivity with ^{32}P differed markedly from that with the external types of radiation. RPS and oocytes were destroyed even by small doses of ^{32}P; a dose of 9.1×10^{-4} μCi/g body weight in males, and 25×10^{-4} μCi/g in females reduced the gonial as well as the oocyte population. Phosphorus-32 also produces dominant lethal mutations in mice. The studies indicate possible hazards of using ^{32}P as a therapeutic or diagnostic agent before or during the child bearing age. (UK)

8063 EFFECT OF IONIZING RADIATION ON TOTAL PROTEIN-BOUND NEUTRAL HEXOSES IN THE PLASMA OF MICE. Evans, Adelbert S.; Quinn, Frances A.; Brown, James A.; Strike, Thomas A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res., 36: 128-37(1968).

Total protein-bound carbohydrates (PBC), as neutral hexoses, were quantified in the plasma of C_3H mice as a function of time relative to whole-body exposure to either monoenergetic 14-MeV neutrons or mixed γ-neutron radiations delivered at a rate of approximately 20 rads/min. The reported doses, 365 to 530 rads, were those that yielded survivors under the stress of daily bleeding. A striking difference was observed between those radiosensitive animals that died after exposure and the more resistant individuals that, although exposed to identical doses, survived the observation period. In the former population, the PBC concentration rose to high values and remained elevated until the death of the animal. By contrast, the survivors showed little change in PBC, deviating only slightly from their preirradiation base-line values. The mean preirradiation PBC concentration in the mice that survived 30 days, while statistically significant ($p < 0.01$) only at the lowest reported dose, was consistently lower than that of those that died during the same period. The magnitude of the difference was inversely related to the radiation dose. The refinement of these data to provide an index to radiosensitivity prior to and prognosis after irradiation in otherwise healthy individuals is proposed. (auth)

8064 CENTRAL NERVOUS SYSTEM SYNDROME OF THE MOUSE: EFFECTS OF STRAIN, AGE, AND CONDITIONING EXPOSURE. Yuhas, John M. (Jackson Lab., Bar Harbor, Me.). Radiat. Res., 35: 714-21(1968).

Through the use of repeated 10,000-R exposures to x radiation it was possible to induce immediate central nervous system death in the mouse. An analysis of five inbred strains of mice demonstrated highly significant differences, although the estimated resistance levels for these strains do not correlate with their respective resistance levels to other radiation syndromes. Female C57BL/6J mice, between the ages of 2 and 20 months, demonstrate a linear increase in central nervous system resistance. As was the case with an array of strains, this age-dependent change in resistance does not correlate with age-dependent changes in resistance to other syndromes. Recovery of the CNS, as estimated by repeated 10,000 R exposures at varying time intervals after 30,000 R, has been shown to be complete by 24 hr after exposure, and by 48 hr the preirradiated mice are in a period of over-recovery. This recovery pattern does not appear to result from a biological advantage held by the preirradiated mice. (auth)

8065 DEFICIENT ^{59}Fe AND ^{125}I–DEOXYURIDINE UPTAKE BY LYMPHO–HEMOPOIETIC CELL TRANSPLANTS ENGAGED IN HOMOGRAFT REACTIONS. Davis, William E. Jr.; Schofield, Raymond; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). J. Cell. Physiol., 71: 185-96(June 1968).

Two test systems were used to study erythropoietic activity of spleen cell grafts measured by ^{59}Fe uptake in x-irradiated recipient mice under conditions in which these grafts were engaged in homograft reactions against allogeneic target cells or in graft-vs host reactions. In the 1st system the recipient mice were exposed to a lethal dose of x rays (900 RAD) and injected intravenously with syngeneic cells from spleen or bone marrow and lymph node. Three days later, bone marrow cells from allogeneic donor mice were injected intravenously as an immunological target. In the second system recipient mice were exposed to 900 RAD and injected intravenously with cells from the spleen, bone marrow, and lymph nodes from allogeneic donors. Incorporation of ^{59}Fe was greatly reduced at seven to 10 days after graft implantation relative to that of control grafts. This reduced erythropoiesis did not occur when the spleen cell graft was immunologically incompetent. Transplantation of bone marrow-lymph node cell mixtures also resulted in a relative decline in ^{59}Fe uptake, but only when minimal numbers (10^5 to 10^6) of marrow cells were injected. The incorporation of ^{125}I-deoxyuridine in the spleen of x-irradiated recipients was used to assess cellular proliferation. Incorporation of this label was reduced when measured seven to 10 days after implantation of the stimulated lymphopoiesis. A concept of depletion of a pluripotent stem cell pool (limited in size under these experimental conditions) due to excessive and concurrent functional demands for erythropoiesis and lymphopoiesis is proposed. (BBB)

8066 INVESTIGATION OF BONE-MARROW STEM CELL PROLIFERATION IN NORMAL, ANEMIC, AND IRRADIATED RATS, USING METHOTREXATE AND TRITIATED THYMIDINE. Blackett, N. M. (Inst. of Cancer Research, Surrey, Eng.). J. Nat. Cancer Inst., 41: 909-18(Oct. 1968).

The proliferation of bone-marrow stem cells that repopulate bone-marrow-depleted hosts was studied in the rat by the use of methotrexate and by the method of tritiated-thymidine suicide. Experiments required to establish the validity of these methods are described. Methotrexate was used to kill cells as they entered a particular stage in the cell cycle, and an estimate was obtained for the mean cell-cycle time for normal rats in the range of from 23 to 35 hours. In conjunction with tritiated-thymidine suicide measurements, it was estimated that the DNA synthesis lasted from 6 to 14 hours. Rats with protracted anemia showed no measurable change from normal in repopulating ability or in the effect of methotrexate, indicating that these cells play no significant part in the maintenance of increased red cell production over an extended period of time. The repopulating ability of rats exposed to continuous γ-radiation at 45 RADs/day, on the other hand, was only 10 to 15% of normal, and with methotrexate it was shown that these cells were proliferating considerably more rapidly than normal. (auth)

8067 EFFECT OF BURSECTOMY AND THYMECTOMY ON THE RESPONSES OF CHICKEN PERIPHERAL BLOOD LYMPHOCYTES TO PHYTOHAEMAGGLUTININ. Greaves, M. F.; Roitt, I. M. (Middlesex Hospital Medical School, London). Nature (London), 220: 293-5(Oct. 19, 1968).

It was shown that neonatal thymectomy with or without irradiation depressed or completely abolished the response to PHA, the degree of reduction being directly related to the completeness of thymectomy. In contrast, bursectomy with or without irradiation marginally enhanced transformation, suggesting that bursa-dependent cells which are associated with antibody production may be insensitive to the mitogenic effect of PHA. (UK)

8068 MATERNAL EFFECT ON REPRODUCTIVE CAPACITY OF IRRADIATED FEMALE MICE. Ehling, U. H. (Oak Ridge National Lab., Tenn.). Z. Naturforsch., 23b: 1476-8 (Nov. 1968).

Virgin female mice from SEC and DBA strains and from crosses and backcrosses between both strains were irradiated with 50 R of x rays. Controls were unirradiated. One day after exposure, each female was caged separately with an unirradiated male. Litters were recorded and killed at birth. The observation time covered the whole life span of the females. The radiation response of females was measured by numbers of young and litters born per female, or by each expressed as a percentage of the comparable unirradiated control group. The number of offspring produced by irradiated females varied from 12 to 57% of that produced by controls. It was concluded that radiosterilization of female mice is genetically controlled. After irradiation differences in reproductive performance between F_1 hybrid females from reciprocal crosses are attributable to a maternal factor. (H.L.W.)

8069 ELECTROENCEPHALOGRAPHIC, IMPEDANCE AND BEHAVIORAL EFFECTS FROM IRRADIATION OF THE HIPPOCAMPAL SYSTEM IN THE CAT WITH 250-keV X RAYS AND 910-MeV HELIUM IONS. Schoenbrun, Richard Lee. Los Angeles, Univ. of California, 1967. 256p.

Thesis.

The effects of focal and whole-brain x irradiation on neurophysiological correlates of conditional approach performance in the cat were studied. Additional studies examined radiation effects on cerebral impedance and autoradiography. Sixty adult male cats were stereotaxically implanted with stainless steel bi-polar recording electrodes placed in the hippocampus, entorhinal area, amygdala, septum, mesencephalic reticular formation, caudate nucleus, and lateral gyrus. After recovery from surgery all animals were trained in a two-choice discrimination to approach a cue light for milk reinforcement of correct responses. Each daily training session consisted of 30 consecutive approach trials. Cerebral impedance across each bipolar electrode tip was measured with a Wheatstone bridge circuit utilizing microvolt signals at 1,000 Hz. X rays were delivered from a collimated source operated at 250 keV, 15 ma tube current with 0.21 mm aluminum and 0.5 mm filtration, with a half-valve layer of 1.7 mm copper. Focal irradiation restricted to the hippocampus utilized highly collimated beams of 4 or 8 mm diameter. 910-MeV helium ions from the 184-inch cyclotron at Berkeley were used to focally irradiate the septum, amygdala or dorsal hippocampus. At the termination of experiments brains were prepared for conventional histology or autoradiography. Tritiated methionine was injected intraventricularly prior to sacrifice in the autoradiographic studies and the brain fixed in formalin, embedded and sectioned. Mounted sections were coated in Kodak HTB-2 and placed at 5°C for periods up to 10 months. Whole-head x irradiations produced patterns of irregular synchrony and spike activity in the hippocampus. Conditioned approach performance was not altered until doses of 1,000 rad or greater were given. Focal x irradiation of the hippocampus in doses of 400 to 2,000 rad produced patterns of sustained, highly regular synchrony in the hippocampus in association with increased approach latency. Lethargy, passivity, and decreased motor performance occurred after both unilateral and bilateral exposures. Decrement in correctness scores occurred only after bilateral exposures to 500 rad. Bilateral hippocampal exposures at 2,500, 5,000, and 10,000 rad produced extreme lethargy, increased approach latency but did not alter correctness. Hippocampal electrical rhythms showed increased amplitude coincident with decreased frequency during both resting and conditional behavior. (TSS)

8070 ELECTRON-MICROSCOPIC INVESTIGATION OF THE COMPENSATORY HYPERTROPHIED ADRENAL GLAND, TOTALLY IRRADIATED BY THE γ-RAYS OF ^{60}Co. Khamidov, D. Kh.; Murtazaeva, L. A.; Mirakhmedov, A. K. (Inst. of Biochemistry, Kiev). Dok. Alad. Nauk SSSR, 182: 969-70(Oct. 1, 1968). (In Russian).

The recuperative power of partially removed hypertrophied adrenal glands exposed to γ-radiation was investigated in male white rats. The right adrenal glands of the animals were first removed and 25 to 30 days later, $\frac{1}{3}$ of the parenchyma of the remaining glands was cut out. After the adrenalectomy, the animals were exposed to 400 R- of γ-radiation; similar resections were made five days later. The tissue specimens of the animals killed at various periods after the operation and the irradiation were studied under an electron microscope. The electron micrograms of normal adrenal tissue indicated zonal differentiation of the mitochondria. The dimensions of the mitochondrial vesicles were found to lie close to the diameter of the smallest cytoplasmatic vacuolae. This is probably owing to the secretive action involving oxidation-reduction and respiratory processes in the tissues.

The effect of irradiation on the compensatory hypertrophy was shown by the onset of destructive processes, edema, and the filling of the organ with blood. Thus, the presence of hypertrophy aggravated the postradiation recovery processes in the remaining parenchyma of the organ. (TTT)

8071 THE ACTION OF LOW X-RAY DOSES ON THE CENTRAL NERVOUS SYSTEM: DETERMINATION OF THE ROLE OF TECHNICAL FACTORS IN IRRADIATION OF THE CENTRAL NERVOUS SYSTEM WITH LOW DOSES. THE ROLE OF THE ASSOCIATED "RATE-DISTANCE" FACTOR IN RABBIT C.N.S. IRRADIATION WITH 50 R. Vasculescu, T.; Nicoara, Z.; Kovacs, M.; Papilian, V. V. Oncol. Radiol., 6: 537-48(1968). (In Rumanian).

The role of technical factors in the biologic action of low x-ray doses on the central nervous system was investigated. The alterations occurring after a single 50 R x-ray exposure of the rabbit head were followed up by histopathological examinations. The presence and dynamics of the alterations, previously described in rat, guinea pig, hen, and dog, were confirmed. Moreover, a biphasic aspect of post-irradiation alterations was noted. First there was a massive discharge at one and six hr relative to the exposure rate; after a 48-hr interval it fell almost within normal values. Secondly there was renewed occurrence of the early alterations within 48 hr and one or six weeks, that subsided or showed a tendency to subside after 48 hr. (Rom. Sci. Abstr.)

8072 UL'TRAFIOLETOVOE IZLUCHENIE. (BIOLOGICHESKOE DEISTVIE I GIGIENICHESKOE ZNACHENIE). (Biological Effects of Ultraviolet Radiation). Dantsig, N. M. (ed.). Moscow, Izdatel'stvo Meditsina, 1966. 360p.

Biological and physiological effects of uv radiation, problems of protection, therapeutic uses, and sources of uv radiation are discussed. Effects of uv radiation on proteins, nucleic acids, viruses, bacteria, and various cells are reviewed. The problems of physiological effects of uv rays on the whole human and animal organism, especially on the functional state of the higher nervous system and immunological reactions of organisms are reviewed. Descriptions are given of the methods and instruments used for measuring uv radiation. (R.V.J.)

Man

Refer also to abstracts 7440, 7953, 7972, 7973, 7978, 7992, 8007, 8022, 8024, 8026, 8038, 8042, and 8045.

8073 CLINICAL RADIATION PATHOLOGY. VOLUME I. Rubin, Philip; Casarett, George W. Philadelphia, W. B. Saunders Company, 1968. 573p. $45.00 (Vols. I and II).

A combined point of view from radiology and pathology are the foundation of this text for physicians. The first volume considers radiopathology on the cellular and tissue levels separately, then separate chapters are included on the radiopathology of the biological systems, including skin, alimentary tract, digestive glands, urinary tract, respiratory system, reproductive system, and cardiovascular system. The effects of therapeutic doses of radiation are discussed for each situation and the subclinical and clinical course of the effects are given. An index and bibliography are provided. (C.O.)

8074 THE BEHAVIOR OF 17-HYDROXYCORTICOSTEROIDS AND 17-KETOSTEROIDS IN THE URINE OF PATIENTS IRRADIATED OVER THE PELVIS. Giannardi, G. F.; Ciampelli, L.; Pistocchi, F.; Ignesti, C.; Franchi, F. (Univ., Florence). Riv. Crit. Clin. Med., 65: 676-80(Dec. 1965). (In Italian).

Adrenal steroid metabolism was studied in 30 women subjected to radiotherapy for uterine or ovarian tumors. Hysterectomy and bilateral ovariectomy were carried out on 25 of the patients before irradiation. Telecobalt therapy was given through anterior and posterior pelvic portals in doses of 200 RAD per session, 1000 RAD weekly, and 5000 RAD in total. 17-Hydroxycorticosteroids (17-OHCS) and 17-ketosteroids (17-KS) were determined in urine 24 hr before the first irradiation, for the first three days of treatment, and then after a 3000-RAD dose level had been reached. In ten subjects determinations were also made two months after completion of radiotherapy. The results revealed a significant fall in both 17-OHCS and 17-KS that continued to the second or third radiotherapy session, then leveled off. The mean levels before; after 200, 400, 600, 3000, and 5000 RAD levels; and two months' postirradiation were as follows: 17-OHCS, 6.0, 5.03, 3.78, 3.65, 3.99, 3.47, and 4.61 mg/24 hr; 17-KS, 5.94, 4.48, 3.78, 3.54, 3.49, 3.76, and 3.71 mg/24 hr. Thus, 17-OHCS showed a maximum 40.6% fall and 17-KS a 39.14% fall from control levels. The 17-OHCS level rose slightly at the termination of radiotherapy but 17-KS values did not. An effect of irradiation on adrenocortical enzymes, especially 21-hydroxylases and 11-hydroxylases, with impairment of steroidogenesis was postulated. The fact that most of the women were ovariectomized indicated the adrenal origin of decreased 17-KS secretion. (BBB)

8075 PREOPERATIVE IRRADIATION FOR HEAD AND NECK CANCER. Berkas, Ernest M. (Veterans Administration Hospital, Detroit). Progr. Clin. Cancer, 3: 186-90(1967).

The occurrence of complications as a result of combined 250-KV x-ray therapy and surgery for head and neck cancers was evaluated. Wound healing after radical neck dissection was studied in 191 patients, 115 of whom had received preoperative irradiation. It was found that wound complications, which included infection or skin slough, occurred in 26% of both groups (i.e., with and without preoperative irradiation). Similarly, when a composite operation (radical neck dissection with excision of intraoral and/or laryngeal lesions) was performed, the wound complication rate was no greater than when irradiation had been given preoperatively. It was further determined that when either radical neck dissection alone or a composite operation was done, less wound complications occurred if transverse incisions were used. Carotid artery rupture after radical neck dissection did not occur in 105 patients, 74 of whom had received preoperative radiotherapy. The incidence of carotid artery rupture was 7% when a standard Y incision was used. (BBB)

8076 LONG-TERM HAZARDS OF THOROTRAST. Boyd, J. T. (Univ. Coll. Hospital Medical School, London); Langlands, A. O.; Maccabe, J. J. Brit. Med. J., 1: 517-21(June 1, 1968).

A search of records of patients receiving Thorotrast at the Department of Surgical Neurology, Edinburgh, from the years 1926 to 1955 inclusive yielded 168 patients who had received Thorotrast either by intra-arterial injection (141) or by direct injection into the cerebral ventricles or subarachnoid space (27). In patients who received Thorotrast by intra-arterial injection, while their subsequent mortality experience reflected the diseases, mainly cerebrovascular, bringing them under investigation, it was notable that there were 12 deaths from cancer (including four primary liver tumors) among the 109 who survived more than one yr after Thorotrast administration. Three of the liver tumors were primary carcinomas of the intrahepatic bile ducts and one was a hemangioendothelioma. In a further case the gross appearances of hemorrhagic liver nodules at operation also suggested hemangioendotheliomatous change. Of the 27 patients who received Thorotrast by direct injection into the ventricular system or subarachnoid space, one died within five yr as a direct result of the disease bringing them under investigation. Seven of the ten five-yr survivors subsequently developed progressive cauda equina lesions, six of which proved fatal. The serious sequelae after ThO_2 deposition in the sacral cul-de-sac were thus amply demonstrated. (BBB)

8077 NEOPLASMS IN YOUTHFUL POPULATIONS FOLLOWING X-RAY TREATMENT IN INFANCY. Hempelmann, Louis H. (Univ. of Rochester, N. Y.). Environ. Res., 1: 338-58(Dec. 1967).

Mail surveys were summarized for two youthful populations (in Rochester, New York and Ann Arbor, Michigan) each with a history of x-ray treatments in infancy for thymic enlargement. The high incidence of neoplasms, previously described for the irradiated Rochester population, was even more striking than before. The new tumors developed mainly in the thyroid and in the irradiated bones of the rib cage. In the examined subgroup, the projected incidence of thyroid nodularity was 28%. Although the incidence of neoplasms in the Ann Arbor study was not as high, it was higher than that in the general population, particularly for thyroid neoplasms. Incidence of thyroid and extrathyroid tumors in the Rochester series was dose-dependent and the frequency of thyroid neoplasms was age-dependent until age 20. The dose response of thyroid tumors was linear in the lower dose range, and there was no threshold, or it was below 20 rad. Other factors, particularly thyroid stress during adolescence, may also play a powerful secondary or promoting role in tumor induction. Induction of thyroid neoplasms in man may follow the multistage theory of carcinogenesis so well established for the development of endocrine tumors in animals. The relatively benign clinical course of all persons with thyroid carcinoma suggests that the disease was still in the hormone (thyrotropin)-dependent stage. Clinical characteristics of the radioinduced neoplasms were described, as well as estimates of the risk of developing thyroid cancer, nodular thyroid disease, and leukemia after irradiation. (BBB)

8078 HYPOPLASIA OF THE GROWING BREAST AFTER CONTACT X-RAY THERAPY FOR CUTANEOUS ANGIOMAS. Kolar, Jaromir; Bek, Vaclav; Vrabec, Radko (Charles Univ., Prague). Arch. Dermatol., 96: 427-30(Oct. 1967).

A follow-up study was done on a series of 14 girls treated with

contact x rays for angiomas in the area of the breast. In 12 patients, the radiation treatments were started during the first year of age, and in the remaining two, within 16 months, with the same contact x-ray equipment at 50 KVP with doses of 100 to 200 R (on the skin surface) daily or three times a week. In one series, total doses of 1000 to 2000 R were administered on the skin surface. Under these conditions, the calculated depth dose (about 1 cm below the skin surface) amounted to only 30% of the skin surface dose. Various degrees of hypoplasia of the breast were encountered in seven subjects. Only when the absorbed doses in the breast were less than 300 R were there no signs of hypoplasia (three patients). In a fourth patient who had received a depth dose of 300 R or more, a slight hypoplasia of the breast was encountered after 16 yr. With higher doses (between 650 to 1000 R in the breast tissue), more evident hypoplasia, but no complete aplasia of the breast was induced in the other patients. Irradiations of the mammary area should be avoided in young girls during the prepubertal age for all nonmalignant tumors. (BBB)

8079 HISTOLOGICAL FINDINGS IN THE BONE MARROW OF AUTOPSY CASES SUBJECTED TO RADIOTHERAPY FOR NEOPLASMS. Hashimoto, M.; Kikuchi, M.; Mitsuyasu, Y. (Kyushu Univ., Fukuoka). Kyushu Ketsueki Kenkyu Dokokaishi, 17: 143-72(1967). (In Japanese).

Histopathologic examinations were made at 58 autopsies of patients who were subjected to local radiotherapy for neoplasms. Specimens of the irradiated and nonirradiated bone marrow were subjected to systematic histologic study. Telecobalt had been used in 48 cases, x rays in seven, and both methods in three cases. The total dose ranged from 600 to 38,600 R, and in 19 it was over 10,000 R. Survival time after irradiation ranged from a few days to 11 yr. In 47 cases, the white blood cell count between the last irradiation and death ranged from 1,800 to 30,300 c/mm^3. In 50 cases the irradiated marrow was hypoplastic and in 16 of these 50 cases it was aplastic. In four out of five cases that survived for one yr or more after radiotherapy, the irradiated marrow showed aplasia, suggesting a prolonged direct effect of irradiation on the marrow. In the 11 cases where irradiated marrow showed a normal cell count, 9 had survived irradiation for less than three months. In six cases the nonirradiated marrow revealed hypoplasia. Out of seven cases where the nonirradiated marrow was extremely hyperplastic, six died within four months of the irradiation. None of the 58 irradiated individuals were diagnosed clinically as having leukemia, but autopsy disclosed one case of a possible acute myelogenous leukemia at an early stage and one of chronic myelogenous leukemia. (BBB) (TSS)

8080 TUMORIGENICITY OF SMALL HIGHLY RADIOACTIVE PARTICLES. Dean, Phillip N.; Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 16: 79-84(Jan. 1969).

A theoretical approach to tumorigenic risk from exposure of skin and lung to particles of high specific activity is described. Present methods of setting guide lines for skin and lung exposures assume uniform radiation fields and are not applicable for small sources where the dose rate falls off rapidly with radial distance from the particle, exposing cells to a wide variety of doses. The method described, based on skin tumor experiments on the rat, is to compute the probability that each cell exposed will form a tumor and to sum for all cells exposed to obtain total tumor probability. Results of the application of this method to β-, α-, and x-ray emitters are presented. (auth) (UK)

8081 CLINICAL RADIATION PATHOLOGY. VOLUME II. Rubin, Philip; Casarett, George W. Philadelphia, W. B. Saunders Company, 1968. 596p. $45.00 (Vols. I and II).

This text for physicians on clinical effects of radiotherapy covers effects on the skeletal system, central nervous system, eye, ear, endocrine glands, muscles, blood and hematopoietic tissues, and embryos and fetuses. Radiation syndromes and radiation carcinogenesis are considered separately. The radiopathologic bases for tumor radiosensitivity and for oxygen effects are discussed along with the time-dose relation. An index and bibliography are provided. (C.O.)

8082 RADIATION HEPATITIS. Lansing, Allan M.; Davis, William M.; Brizel, Herbert E. (Univ. of Louisville, Kentucky). Arch. Surg., 96: 878-82(June 1968).

An unusual case of jaundice mimicking the Budd-Chiari syndrome in a patient who received radiotherapy following surgical removal of a hypernephroma and its extension into the vena cava was reported. A 47-yr-old woman underwent a right nephrectomy for a 10-cm anaplastic and partly necrotic adenocarcinoma, and the inferior vena cava was opened to permit removal of a 15-cm tumor thrombus along with a small portion of the vein wall. The vena cava was ligated below the left renal vein. The patient received postoperative irradiation to the tumor area (diaphragm to left iliac crest to midline). The total dose of irradiation was 4500 R given by betatron with 25-MeV x rays over a 33-day period. The patient was admitted to the hospital four weeks after completion of radiotherapy with sudden onset of severe right upper quadrant aching pain. The clinical picture mimicked the Budd-Chiari syndrome. The results of serial liver function tests, hepatic scan, angiography, and liver biopsy, combined with a deteriorating clinical condition, led to surgical exploration of the inferior vena cava and hepatic veins. No major hepatic vein obstruction was present, and the diagnosis of radiation hepatitis was established. The primary function was damage to, and thrombosis of, the small intrahepatic veins causing intense hepatic congestion. The liver was not resistant to modern deep radiation therapy, and in fact was one of the more sensitive tissues. (BBB)

8083 EFFECTS OF RADIATION THERAPY ON LARYNGEAL FUNCTION. Werner-Kukuk, Elvira; von Leden, Hans; Yanagihara, Naoaki (Univ. of Southern California, Los Angeles). J. Laryngol. Otol., 82: 1-15(Jan. 1968).

Objective measurements of the laryngeal function and voice were performed on a patient with extensive leukoplakia and a bilateral carcinoma of the vocal cords before, during and after ^{60}Co teletherapy. The results of the aerodynamic and acoustic investigations were compared with the clinical findings and ultra high-speed photographic studies. Two weeks after the start of teletherapy, an indirect laryngoscopic examination showed little change in the gross appearance of the larynx, except for moderate injection and edema of the laryngeal mucous membranes. Photographic evidence was obtained of the inflammatory reaction that might have been responsible for the further restriction of amplitude in the vibratory movements of the vocal cords as seen on ultra high-speed motion pictures. Although visual examination at this stage did not show any significant changes in appearance, the results of the aerodynamic investigation demonstrated measurable changes in laryngeal efficiency. The mean flow rate decreased to 169 cm^3/sec and the total air volume to 2290 cm^3. The maximum phonation time declined to 7.2 sec during the first week, but improved steadily in subsequent weeks. Instability of laryngeal function during the early part of the radiation treatment was evident. Superimposition of the underlying pathological lesion and the acute inflammatory reaction resulted in an increase in noise components. Owing to vocal cord hyperemia caused by the irradiation, complete interruption of periodicity resulted, that was common in the highest degree of hoarseness. It was concluded that during the early stages of ^{60}Co teletherapy, all methods of examination demonstrated a deterioration of the laryngeal function. This impairment in function was explained by the superimposition of two factors, the neoplastic infiltration of the soft tissues and the inflammatory reaction from irradiation. The resulting increase in mass, induration, and irregularity restricted the amplitude of the vibrations and prevented a close approximation. This combination resulted in a high air flow rate, increased fluctuation, lowered air volume, and a marked decrease in the maximum phonation time. These physiologic changes were accompanied by a deterioration of the acoustic signal, interruption of the periodicity, and a further increase in noise components. (BBB)

Radiation Effects on Plants

Refer also to abstracts 7928, 7933, 7934, 7940, 7972, 7973, 7976, 7977, 7979–7981, 7983, 7984, 7988, and 7991.

8084 STUDY ON THE EFFECTS OF ^{60}Co γ-RAY IRRADIATION ON THE GROWTH AND YIELD OF CROPS. Kaneki, Yoshizo (Tokyo Univ.). Mem. Tokyo Univ., Agr., 12: 37-124 (Mar. 1968).

Growth studies of crops irradiated with γ rays were made to clarify the types of growth reaction resulting from γ irradiation, and to investigate mechanisms causing the lesion of growth functions. For barley, rice, and wheat, the following are described: the germination and initial stage of growth of crops grown from seeds subjected to γ irradiation; the growth and yield of the crops, grown from γ irradiated seeds; the growth and yield of the crops irradiated at the turning point of development; the growth and yield, relating to the nutritional condition, of rice irradiated as the adult seedling; physiological aspects of the irradiated crops; and the causes of lesion of growth functions of irradiated crops. (NSA of Japan)

8085 INTENSITY OF THE PHOTOSYNTHESIS OF OREGON ASH GROWN FROM IRRADIATED SEEDS. Kudinov, M. A. Bot., Issled., Beloruss. Otd. Vses. Bot. Obshchest., No. 9, 134-6(1967). (In Russian).

Seeds of Oregon ash were γ irradiated at doses of 500 to 15,000 R. The highest dose did not affect growth, but all other doses stimulated growth of 2-yr-old seedlings. The photosynthesis of

the seedlings, as measured by ^{14}C radiometric method, was three to 16 times more intense than that of control seedlings grown from unirradiated seeds. Even though the 15,000 R dose did not affect growth, photosynthesis was affected, probably because of an increase in respiration. (TSS)

8086 RADIATION-INDUCED CHROMOSOME EXCHANGES IN CAMPELIA ZANONIA (L.) HBK: DISTORTION HYPOTHESIS AS AN ALTERNATIVE TO A LIMITED NUMBER OF SITES. Savage, J. R. K.; Papworth, D. G. (Medical Research Council, Harwell, Eng.). Nature (London), 220: 87-9(Oct. 5, 1968).

On the basis of observations that in some materials exchanges of the dicentric and centric ring types are distributed between nuclei in an under-dispersed binomial manner, and that the radiation dose-response curves for these changes eventually saturate, it has been inferred that the number of exchange sites must be very limited. In the present communication an alternative suggestion is presented, which was applied to dicentric and centric ring chromosome exchanges in Campelia zanonia (L.), and which accounts for both the observed binomial distributions and the dose-response curve saturation, without the necessity of involving any limitations of the number of sites or the number of exchanges which can take place. The final distribution of observed exchanges between nuclei is derived from the summation of a number of distorted binomials, and will itself be distorted in a similar manner, having a reduced mean and variance. Asymmetrical and symmetrical exchanges are equally likely. The process of distortion leads to a progressive loss of exchanges as the number of events (pairs of lesions in a state of exchange initiation) increases. There is no reason to assume that the process of distortion is confined to Campelia, and it may well account for other cases of non-random exchange distributions and saturating dose-response curves. (UK)

8087 ON THE DIRECT ACTION OF ^{60}Co γ-RADIATION EFFECT IN CONIDIA DEMATIACEAE. Zhdanova, N. N.; Pyankov, G. N.; Bondar, A. I. Izv. Akad. Nauk SSSR. Ser. Biol., No. 4, 584-90(July-Aug., 1968). (In Russian)

The irradiation of two Dematiaceae species in dry state and in water showed their greater resistance to direct action of ^{60}Co quants than mixed one (the direct plus indirect conditioned by products of water radiolysis). This suggests a more complete manifestation of protective reactions observed in fungi in relation to their exposure to high doses providing conditions are close to natural. The direct action of γ rays upon Cladosporium sp. and Pullularia sp. revealed once again an unequivalent, unmonotonous relation of conidia's survival depending upon different dose rate. (auth)

8088 RECOVERY FROM RADIATION-INDUCED LETHAL SECTORING IN YEAST. James, A. P.; Saunders, Alexa S. (Chalk River Nuclear Labs., Ontario). Can. J. Genet. Cytol., 10: 283-93(June 1968).

Recovery from the x-ray-induced damage responsible for lethal sectoring was investigated in diploid yeast. Lethal sectoring, an important factor in lethal damage, is characterized by the sporadic appearance of clusters of dead cells in earlier post-irradiation vegetative generations of surviving cells. Recovery from the instability responsible for sectoring was evident in a gradual decline in the frequency with which sectors were initiated through successive generations. This decline was shown to result from the fact that unstable cells, though able to persist indefinitely, had a propensity for reversion as well as for lethal sectoring. Some lines of descent from unstable cells lost their ability to revert without losing their ability to produce lethal sectors. (auth) (Canada)

8089 THE STABILITY OF NADSONIELLA NIGRA TO THE ACTION OF SHORT-WAVE ELECTROMAGNETIC IRRADIATION. Ruban, E. L.; Lyakh, S. P. (Inst. of Microbiology, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 3, 402-7(May-June 1968). (In Russian).

The comparative stability of white and black yeasts to radiation is reviewed. It was shown that yeasts containing black pigment (Nadsoniella nigra strain 365) isolated from primitive soil collected in the area of an Antarctic island, appeared to be much more stable to the action of short-wave electromagnetic radiation (uv light, γ- and x-ray), than white yeasts (Candida utilis strain 295). (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 7930, 7954, 7955, 7986, 7990, 7997, 8033, and 8103.

8090 (NYO-3319-19) SIMILARITIES IN THE DOSE-RESPONSE OF p-HYDROXYMERCURIBENZOATE BINDING IN IRRADIATED AND IN HEATED BACTERIA. Freedman, M. L.; Freedman, P. L.; Bruce, A. K. (State Univ. of New York, Buffalo. Dept. of Biology). Apr. 21, 1968. Contract AT(30-1)-3319. 10p. (CONF-680421-3). Dep. CFSTI.

From 16th Annual Radiation Research Society Meeting, Houston, Tex.

Stationary phase cultures of Micrococcus radiodurans, Sarcina lutea, and Escherichia coli B/r in phosphate buffer exposed to 200 kVp x rays at doses to 3 MR were incubated with p-hydroxymercuribenzoate (p-HMB) for assay of sulfhydryl content. Amounts bound were quantitated per colony-forming-unit by neutron activation analysis. Results indicated that M. radiodurans possesses freely reacting sulfhydryls in amounts disproportionately greater than either E. coli or S. lutea. X irradiation and heat appeared to reduce the amount of sulfhydryl in M. radiodurans either by radical mediated oxidations or by disulfide or hydrogen sulfide formation. In E. coli and S. lutea, however, unmasking of sulfhydryls or disulfide cleavages mediated by x irradiation or heat denaturation proceeded faster than sulfhydryl inactivation. A plateau was reached where both processes proceeded at essentially the same rate, followed by a net sulfhydryl inactivation comparable to that seen in M. radiodurans. (auth) (TSS)

8091 GENETICAL AND PHYSIOLOGICAL INVESTIGATIONS OF X-RAY-RESISTANT STRAINS OF THE BACTERIUM ESCHERICHIA COLI. Axelrod, David Eugene. Knoxville, Tenn., Univ. of Tennessee, 1967. 92p.

Thesis.

A mutant (R5) of the bacterium Escherichia coli K12 that is more resistant to the lethal effects of x radiation than its parent (H) when assayed for colony forming ability was isolated. The genetic and physiological differences between strains R5 and H were studied. (Disser. Abstr.)

8092 RAPID MIXING IN RADIOBIOLOGY. Adams, G. E.; Cooke, M. S.; Michael, B. D. (Mount Vernon Hospital, Northwood, Eng.). Nature (London), 219: 1368-9(Sept. 28, 1968).

The mechanism by which N-ethylmaleimide (NEM) sensitized bacteria to the lethal effects of radiation has not been elucidated. It was suggested that removal of naturally occurring radioprotective SH groups could explain the effect; this hypothesis could be eliminated if it were possible to demonstrate the sensitization when the interval of time between addition of NEM and irradiation was too short for the thermal reaction between SH and the sensitizer to take place. Experiments are described, using a rapid-mixing apparatus, in which this condition was fulfilled. Serratia marcescens was employed in the studies. Irradiation was with 1,750 2-μs electron pulses from a 1.8 MeV linear accelerator, with a 350/s pulse repetition frequency, together with ferrous sulphate dosimetry. It was established that the NEM was non-toxic in the absence of radiation. A high degree of sensitization of anoxic bacteria was produced by large concentrations of NEM present 4 ms before irradiation or by low concentrations present for longer times. NEM added 4 ms after irradiation produced a small degree of sensitization. Very little sensitization was observed when anoxic NEM was mixed with aerated bacteria 40 ms before irradiation. Addition of bacteria to irradiated NEM involved no sensitization, indicating that the effect was not a result of the production of toxic radiolytic products. It was also indicated that the chief mechanism was not a result of the inhibition of long term repair processes by interaction of NEM with some repair enzyme. Since the sensitization in these rapid mixing experiments took place over a contact time very much less than the time likely to be required for suppression of intracellular –SH, it was concluded that the mechanism did not involve the suppression of –SH groups normally present in the cell, and that the extreme rapidity of the effect indicated participation of free radical precursors in some fast reaction. Diffusion of NEM to sites in the bacterium was briefly considered; the diffusion might involve transport through a multi-compartment system containing several membrane barriers. (UK)

8093 PHYSICOCHEMICAL STUDIES ON X-RAY INACTIVATION OF BACTERIOPHAGE. Freifelder, David (Brandeis Univ., Waltham, Mass.). Virology, 36: 613-19(Dec. 1968).

The rates of loss of plaque-forming ability by x-irradiation of phages T4, T5, T7, and λ have been determined. By ultracentrifugal analysis of DNA isolated from irradiated phages the rates of double-strand breakage have also been measured. By a comparison of all these curves, the rates of killing caused by mechanisms other than strand breakage (presumably base damage) have been calculated. For T4, T5, and T7 double-strand breakage accounts for about half of the killing. Furthermore, the rates of double-strand breakages, T4 included, are proportional to the molecular weight of the DNA. For T4 most of the killing is due to strand breakage. Lack of inactivation by base damage seems to account

for the relative resistance of T4 to x-rays. This resistance is not due to glucosylation or repair of double-strand breaks and probably not due to the presence of 5-hydroxymethylcytosine. It is unlikely that it is a result of there being only a very small region of the genome in which an x-ray hit is lethal. It is proposed that T4 can in some way repair damaged bases although neither the v nor x systems, both of which are involved in ultraviolet repair, can be responsible for this. (auth)

Radiosterilization and Radiopreservation

8094 (NP-17534) FOOD IRRADIATION ACTIVITIES THROUGHOUT THE WORLD. (Business and Defense Services Administration, Washington, D. C.). [1966]. 91p. GPO $0.50.

Organizations, details of their installations, and program activities are listed according to countries of the world in Part I. An outline of food irradiation programs in the United States is presented in Part II. Principal international organizations engaged in or sponsoring food irradiation program activities are listed in Part III. The purpose, membership, and activities of each are briefly described. (H.L.W.)

8095 (NYO-3573-1) LONG-TERM DOG FEEDING EXPERIMENTS ON RADIATION-PASTEURIZED FOODS. Final Report. Fegley, Harry C.; Edmonds, Russell S. (AME Associates, Princeton, N. J.). Aug. 20, 1968. Contract AT(30-1)-3573. 383p. Dep. CFSTI.

Data are summarized for a long-term feeding experiment on dogs maintained on a diet that contained about 50% γ-irradiated softshell clams. The clams were processed by exposure to doses of 400,000 or 800,000 rads γ radiation, followed by storage at 33 to 35°F for 30 days before blast freezing. Data on weight, hematology, urine analysis, fecundity, and survival time of the dogs are compared with data on a control group that was maintained on a normal diet. Both male and female pups whose parents received a normal diet were significantly smaller than those from parents on the irradiated clam diet. The weights of liver, kidneys, and spleens were also below those of dogs on the clam diet. A significant inverse correlation was observed between the dose of radiation received by the clams and the blood urea nitrogen level of male dogs, but no similar correlation was observed in females. No other effects of irradiated clams in the diet were observed. (C.H.)

8096 RADIOBIOLOGICAL PARAMETERS IN THE IRRADIATION OF FRUITS AND VEGETABLES. Romani, Roger J. (Univ. of California, Davis). Advan. Food Res., 15: 57-103 (1966).

The following topics relating to the use of ionizing radiation to increase the storage life of fruits and vegetables were reviewed: radiation units and dosimetry, radiation mechanisms (temporal, quantitative, and spatial aspects), chemical and biochemical events in irradiated fruits and vegetables (immediate and protracted chemical changes and cell-wall constituents), metabolic aspects (intracellular studies, involvement of phytohormones, and repair), radiation sources, irradiators especially designed for the low-dose food irradiation program, types of research facilities in general use for food irradiation, commercial units, and future research needs. Though β and γ sources were used in experimental food irradiation, the choice was often dictated by source availability or size of package and need for penetrating power. Thus far, little was done to exploit the penetration characteristics of different radiations to experimental advantage. Few well-defined, direct radiochemical changes were noted in irradiated fruits and vegetables. Ascorbic acid, an exception, was affected immediately and noticeably by radiation, probably because of its redox function. (BBB)

8097 EFFECTS OF IONIZING RADIATIONS ON EGGS. Varela, Manuel Gonzalez. An. Inst. Invest. Vet. (Madrid), 16/17: 115-28(1966/67). (In Spanish).

The effect of ionizing radiation on whole eggs was investigated at three different levels. They were stored under rigorous conditions (20°C ± 0.5°, 60% relative humidity). Sterilization of Pseudomonas aeruginosa did not occur. The radiation produced a loss of weight. Turbidity was increased in the thin white by decrease of the thick white. At doses of over 5.0×10^5 rads the shell was fragile, directly proportional to the highest level of radiation received. The radiation didn't protect against external contamination. The aging effects were added to the deteriorative effects of the radiation. However, the irradiated eggs were classified as grade B (U.S.D.A.) after 42 days, and looked better than the control eggs. (auth) (TSS)

8098 TECHNICAL ASPECTS OF FOOD IRRADIATION. Robijns, K. G. (Tijdschrift voor Diergeneeskunde, Utrecht). Tijdschr. Diergeneesk., 92: Suppl. 1, 40-54(1967). (In Dutch).

Ionizing radiation is useful in food preservation because of its effects on bacteria, fungi, or insects that may be present and because of its physiological effects in delaying ripening or sprouting. In addition, chemical changes take place that may render the food unacceptable to the consumer. These organoleptic changes take place at high doses and can be controlled somewhat by combination treatment with another preservation method, such as freezing, heating, or salting. Since enzymes are not affected at doses used for food, enzymatic spoilage is not prevented by radiation alone. Radiation has slight effect on the nutritive value of foods. Animal experiments indicate that no carcinogenic or toxic products are produced in irradiation. The radiation procedure and dose used are classified as radappertisation, radicidation, or radurisation depending on the purpose intended for a particular product. Wholesomeness tests with animals are conducted after processing. (C.O.)

8099 THE EFFECTS OF GAMMA IRRADIATION AND REFRIGERATION ON SPOILAGE AND MICROBIAL POPULATION IN GUAVA PUREE CONCENTRATE. Brekke, John E. (Hawaii Fruit Lab., Honolulu); Tonaki, Keith; Moy, James H. Food Irradiat., 8: No. 4, 10-15 (Apr.-June 1968).

A puree was prepared from guava fruits, and small portions of spoiled guava puree were added to puree concentrates. The microbial populations of the purees were determined before and after irradiation. Samples of inoculated purees were γ-irradiated with 100, 500, and 1000 kRad. At intervals of several days, microbial assays were made by series dilution and plate cultures. Yeasts appeared in greatest abundance; bacteria and molds were also present. The unirradiated samples were spoiled on the second day at 75°F; those held at 45°F were spoiled at 4 to 6 days. Irradiation at 100 kRad reduced the number of viable cells but did not extend the storage life at 75°F to an important degree, as spoilage occurred in 4 to 6 days. At 45°F, 100 kRad samples were more stable; microbial populations of these samples approximately doubled in 4 to 6 days, but evidence of spoilage was absent. Concentrates irradiated at 500 and 1000 kRad showed large increases in cell count during storage at 75°F; held at 45°F these samples showed a steady decrease in microbial population. Results indicate that radiation combined with refrigeration offers promise as a technique for preservation of guava puree concentrate and similar products. (H.L.W.)

8100 THE EFFECT OF LOW LEVEL GAMMA IRRADIATION ON PEACHES. Larmond, Elizabeth; Hamilton, H. A. (Food Research Inst., Ottawa). Food Irradiat., 8: No. 4, 2-9 (Apr.-June 1968).

The effect of irradiation doses of 150, 200, and 250 kRad on the shelf-life and eating quality of Veteran peaches was studied. These levels did not affect flavor, texture or color as evaluated by a taste panel, but were effective in controlling rot for four weeks. Ascorbic acid development was slightly delayed. Less force was required to puncture the skin of the radiated peaches than that of the controls. (auth)

8101 BELGIUM: PROGRESS OF WORK ON FOOD IRRADIATION. Food Irradiat., 8: No. 4, 16-21 (Apr.-June 1968).

Progress in research on food irradiation is reported from the following institutions: Central Laboratory of the Ministry of Economic Affairs, Foodstuffs Preservation Laboratory, Louvain University; Centre d'Etude de L'Energie Nucleaire; Institute of Genetics, Liege University; Institut National pour l'Amelioration des Conserves de Legumes; and Ministry of Agriculture State Research Station. Research projects included: radiation processing of flour; radiation processing of commercial wheat samples; radiation effects on shelf life of potatoes, carrots, lettuce, and apples; frequency of lethal dominant mutations in mice fed on an irradiated diet; radioinduced sprout inhibition in potatoes, radiation effects on ripening of apples; radioresistance of Clostridium sporogenes; and wholesomeness tests. (H.L.W.)

8102 OBSERVATIONS ON THE LOW-TEMPERATURE IRRADIATION OF MILK. Scanlan, R. A.; Lindsay, R. C. (Oregon State Univ., Corvallis). J. Dairy Sci., 51: 1967-8(Dec. 1968).

Irradiation of milk in the fluid state to a dose of 4.5 megarad promoted extreme browning and caramelization. When the milk was irradiated in the frozen state at −80 and −185°C an extremely bitter flavor resulted. All of the irradiated milks were regarded as unacceptable by the flavor panelists. The fractionation of irradiated milk containing the bitter flavor suggests that the bitter component was a protein or a nondialyzable protein fragment. (auth)

8103 EXPERIMENTAL RADURISATION OF MINCED BEEF. INFLUENCE ON PRESERVATION AND ON THE RADICIDATION OF DIFFERENT SEROTYPES OF SALMONELLA. Billon, J. (Veterinary Service Lab., Paris); Serrano, D. de la Sierra. Food Irradiat., 8: No. 4, 22-7 (Apr.-June 1968).

Samples of minced beef were subjected to varying doses of γ radiation. Some of the samples were inoculated with a mixture of Salmonella typhimurium, S. infantis, S. meleagridis, and S. munchen before irradiation. Results indicated that irradiation of minced meats gave them a shelf life compatible with profitable commercialization. Doses of 250 krad were sufficient to reduce the salmonella content to a level presenting no danger for the consumer. It was also shown that the shelf life of minced meats depended on the strictness with which existing public health regulations are observed during their preparation. (H.L.W.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 8645, 8661, 9257, 9262, and 9263.

8104 (GEMP–1006) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM. Progress Report No. 74. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). June 29 1968. Contract AT(40-1)-2847. 195p. Dep. CFSTI.

Evaluation and testing of high-temperature physical and mechanical properties of materials for use in fueled and non-fueled reactor applications include Mo, W, Re, Re–W, Mo–Re–W, and stainless steels. Radiation effects on fast breeder reactor cladding and structural materials are investigated. Information is presented on creep-rupture of Incoloy 800, plastic fatigue of Type 316 stainless steel, creep-rupture of polycrystalline Mo, isochronal resistivity recovery of Mo, and microhardness of Mo–Ti, V, and W. Tubing of Re–W and Mo–Re–W development procedures are given. Removal of carbon impurities from Mo was studied in moist hydrogen and argon atmospheres. Creep-rupture results on chromium-base alloys for fuel cladding materials are given. Tensile data and Poisson's ratio were obtained for AISI 304, 316, and 348 stainless steel at strain rates and temperatures corresponding to those used in fatigue testing. Property data for Cr–Mo–Ni steel, PH 13-8 Mo steel, and Inconel 718 are tabulated. Dynamic testing of the combined effects of internal pressure and steam oxidation on the deformation and failure characteristics of zircaloy-4 continues. Studies of the phase relationships and melting behavior in the Zr–UO_2 pseudobinary system were begun and the measurements on the effects of oxidation on the thermal radiative properties of zircaloy-4 continue. Fast breeder reactor thermocouple development includes a dynamic inpile experiment to measure calibration changes resulting from transmutation of W and Re–W thermoelements. (J.C.W.)

8105 (LA-DC–9669) OXYGEN TRANSPORT IN SODIUM. McPheeters, Charles C.; Biery, John C. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 18p. (CONF-681106–1). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

The cold trapping experiments indicated that increased Reynolds' number had a profound effect on the rate of removal of oxygen from the system. This velocity effect indicates that the rates are diffusion limited. Increased Reynolds' number caused an increase in the mass transfer coefficient proportional to the first power of the Reynolds' number. Cold trap temperature and absolute concentration had little effect on the mass transfer coefficient as shown by the observation that the dissolution and precipitation rate constants were nearly equal in coupled constant velocity runs. However, the rate coefficients were found to be a function of the initial concentration driving force. The implication is that the character of the precipitate and its specific area were modified by the driving force available for nucleation of the initial crystals. Breakaway of oxide deposits in the cold trap was observed. This phenomenon points out an important function of packing materials–that of holding the oxide deposits in position and preventing recontamination of the system by oxide breakaway. (auth)

8106 (ORNL–4370) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1968. Peterson, Sigfred (comp. and ed.) (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 276p. Dep. CFSTI.

The report is divided into 41 sections. A separate abstract was prepared for each section. (P.G.C.)

For abstracts of individual sections see: 7664, 8107, 8110, 8111, 8131–8134, 8158–8170, 8213–8216, 8245–8247, 8271–8276, 8304–8306, 8322, 8323, 8339, and 8340.

8107 (ORNL–4370, pp 230-4) METALLOGRAPHY. Gray, R. J. (Oak Ridge National Lab., Tenn.).

A completely contained alpha metallography glove box line was fabricated, equipped, and leak checked. It consists of eight boxes in line for specimen preparation and microscopic examination. Two isolated boxes are for hardness testing, mensuration, and photomicrography. Electron microscopy was added to the responsibilities of the High Radiation Level Examination Laboratory. Replicating techniques were developed to allow examination of highly radioactive (>30,000 r/hr) specimens routinely. A catalogue of photomicrographs of arc-cast and heat-treated uranium carbides was reported; chemical and x-ray data were provided. Evaluation of an image analyzing computer for quantitative metallography was continued and compared with results from other methods. Computer programming was used to improve techniques and capabilities of x-ray probe analyses and to achieve element detection of amounts as low as 40 ppM. (auth)

Corrosion and Erosion

8108 (AI-AEC–12685) THE SOLUBILITY OF OXYGEN IN LIQUID SODIUM: A RECOMMENDED EXPRESSION. Eichelberger, R. L. (Atomics International, Canoga Park, Calif.). Nov. 1, 1968. Contract AT(04-3)-701. 21p. Dep. CFSTI.

The solubility of oxygen in sodium as reported in nine publications from eight laboratories was reviewed, and criteria established for the selection of data to be used to derive a recommended solubility curve. The recommended curve, based on 107 solubility determinations from five laboratories, is described by the equation: log S(wppM O) = 6.239 – 2447/T(°K). (auth)

8109 (IN–1185) CORROSION EXPERIENCE WITH TYPE 316 STAINLESS STEEL IN SODIUM–POTASSIUM EUTECTIC ALLOY AT 1400°F. Hoffman, T. L. (Idaho Nuclear Corp., Idaho Falls). Oct. 1968. Contract AT(10-1)-1230. 37p. Dep. CFSTI.

Service test examinations were performed on the Type 316 stainless steel loop for circulating sodium–potassium (NaK) eutectic alloy in the Waste Calcining Facility at the Idaho Chemical Processing Plant. These examinations of the stainless steel loop revealed the cumulative effects of 24,300 hours of operation at 1100 to 1400°F during the last six years. Although Type 316 stainless steel performed satisfactorily and is still being used in this service, the results showed that changes in mechanical properties and metallurgical effects occur with circulating nonisothermal NaK in contact with Type 316 stainless steel. Some mass transfer of alloying elements from the hot regions of the Type 316 stainless steel loop to the colder regions was observed. The mitigation of these effects is discussed. (auth)

8110 (ORNL–4370, pp 47-51) SURFACE REACTIONS OF METALS. Cathcart, J. V. (Oak Ridge National Lab., Tenn.).

The oxidation mechanisms of Nb and Ta were studied in the range of 700 to 900°C. At low oxygen pressures stress effects related to oxygen solution in the metal were isolated. Good agreement was obtained between surface stresses measured by flexure techniques and those computed on the basis of ideal bulk diffusion in the specimens. Studies of the thin-film stage of the oxidation of Ni confirmed the existence of paths of easy diffusion in the NiO films and underscored their importance in the oxidation process. Ellipsometer studies of the NiO films lead to the conclusion that the refractive index of NiO changes with film thickness and there is some evidence that this change may be associated with a change in the concentration of Ni^{3+} ions in the film. An anodic-film sectioning technique was used in the study of diffusion in W. By using section thicknesses ranging down to 10 Å it was able to measure coefficients as small as 5×10^{-18} cm^2/sec. An Arrhenius plot is given for the diffusion of ^{95}Nb in W over the range 1400 to 2400°C. (auth)

8111 (ORNL–4370, pp 76-84) ALKALI–METAL CORROSION OF HIGH-TEMPERATURE MATERIALS. DeVan, J. H.; Litman, A. P.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Cumulative operating time of refractory-metal-boiling-K corrosion experiments passed the 100,000 hr period. Mass transfer has been seen only in unalloyed Nb,W, and W-25% Re systems. In W and W-25% Re the mass transfer effects were opposite to those expected from concentration-gradient considerations and are thought to be associated with gaseous impurities. Examination of an Nb-1% Zr loop containing a TZM nozzle-blade section revealed excellent compatibility of these materials in boiling K after forced-flow, engineering-scale testing at 1200°C for 3000 hr. A second forced-circulation loop constructed of the Nb alloy D-43 completed a scheduled 10,000-hr run at 1300°C with a load factor of 96%. In tests of the Nb alloys D-43, Nb-1% Zr and FS-85 in circulating Li (1) Zr and N were preferentially transported from hotter to cooler surfaces, (2) Zr depletion was controlled by solid-state diffusion, (3) Nb mass transfer became significant at 1300°C, and (4) the corrosion rate was the same for any given temperature in the loop, independent of location and direction of heat flux. The design, component procurement, and weld development were completed for the first in a series of forced-circulation Li loop tests on Ta and W alloys at maximum temperatures of 1370 and 1540°C. A T-111 pump cell for the helical induction pump for these tests

was successfully fabricated and tested to 815°C in K to verify its structural integrity and establish performance characteristics. Evaluation of a dissimilar-metal NaK radiator circuit with a type 316 stainless steel to Nb-1% Zr alloy surface area ratio of 5.5 showed a corrosion rate no greater than 1×10^{-4} in./yr and satisfactory mechanical properties after 6000 hr operation at 680°C. In studies of the Ta–O–K system at 600, 800, and 1000°C a temperature-dependent threshold oxygen concentration in the Ta was found at which K penetrates the Ta; this threshold concentration is higher than that observed in similar studies of the Nb–O–Li and Ta–O–Li systems. The role of oxygen in the corrosion of refractory metals by alkali metals was analyzed in terms of thermodynamic interaction parameters; oxygen activity coefficients derived from this approach offer a reasonable explanation for the distribution coefficient discrepancies previously reported in these systems. A Zr gettering technique was developed for oxygen determination in alkali metals in the concentration range 100 to 1000 ppM. The fast-neutron activation technique was proved effective for the determination of oxygen in K and Li at concentrations as low as 20 ppM. (auth)

8112 OXIDATION BEHAVIOR OF SILICIDED COLUMBIUM–TITANIUM BINARY ALLOYS. Felten, Edward J. (Pratt and Whitney Aircraft, Middletown, Conn.). Electrochem. Technol., 6: 438-47(Nov.-Dec. 1968).

Titanium-modified niobium disilicide coatings, prepared by siliciding Nb, Nb-5Ti, Nb-10Ti, and Nb-15Ti, were evaluated in oxidizing and neutral atmospheres between 800 and 1200°C. The oxidation resistance of the coatings increases as their titanium content is increased. Oxidation resistance is related both to the composition of the oxide formed on the coatings and to thermal crack formation. The titanium-modified disilicides have less diffusional stability than niobium disilicide. At 1000°C and higher, a new titanium-rich ternary MSi phase forms in substantial amounts, both as a dispersion within the MSi_2 phase and as a discrete layer between the MSi_2 and M_5Si_3 layers in the coating. The MSi phase is less oxidation resistant than the disilicide phase. Preferential oxidation of the MSi phase is the potential failure mechanism for titanium-modified silicide coatings at 1200°C and above. (auth)

8113 INFLUENCE OF A NEUTRON IRRADIATION ON THE CORROSION-CHEMICAL CHARACTERISTICS OF AN AUSTENITIC 18-8 CHROMIUM–NICKEL STEEL. Herbsleb, G.; Schwenk, W. (Mannesmann Forschungsinstitut, Duisburg, Ger.). Nukleonik, 11: 228-33(Sept. 1968). (In German).

The corrosion-chemical behavior of a stainless steel austenitic Cr–Ni steel of type X 5 CrNi 18 8 was investigated after irradiation with a neutron dose of 4×10^{19} neutrons/cm^2 (E > 1 MeV) and compared with the behavior of nonirradiated material. The samples were tested in the Strauss and Huey tests and by potentiostatic research in boiling 2N H_2SO_4 in the active, passive, and transpassive regions of the current voltage curve. The stability with respect to pitting corrosion was determined in 1M NaCl solution. No clear effect of irradiation on the corrosion behavior was found. A slight increase of the corrosion velocity of irradiated samples in nitric acid is possibly caused by increase of the ferrite content as a result of the irradiation. (tr-auth)

8114 EFFECT OF IMPURITIES ON THE DEFECTS IN OXIDES AND THEIR RELATIONSHIP TO OXIDATION OF METAL. Kofstad, Per (Central Inst. for Industrial Research, Oslo). Corrosion, 24: 379-88(Nov. 1968).

The defect structure of the oxygen-deficient oxides of Nb_2O_5, Ta_2O_5, and ZrO_2 is discussed. It is suggested that the oxygen vacancies are probably the important defects, except possibly at the most oxygen deficient part of the homogeneity ranges where interstitial cations may predominate. At high oxygen pressures, (small deviations from stoichiometry) effects of impurities become important and probably determine the point defect concentration. Oxidation of Nb, Ta, Zr, resulting in growth of compact scales of Nb_2O_5, Ta_2O_5, and ZrO_2, is discussed on the basis of these considerations. It is shown that effects of impurities may explain apparent deviations from the simple behavior predicted by the Wagner theory. Analysis and control of impurities is essential in interpretation of defect structures of oxides and defect-controlled properties and reactions. (auth)

8115 STUDIES OF CORROSION OF ZIRCONIUM ALLOYS BY CARBON GAS. I. OXIDATION OF Zr–Cu ALLOYS. Guerlet, J. P.; Lehr, P. (Centre d'Etudes de Chimie Metallurgique, Vitry sur Seine, France). J. Nucl. Mater., 28: 152-64(Nov. 1968). (In French).

A study has been made of the resistance to oxidation by carbon dioxide of zirconium-copper alloys containing 2.5 wt % copper. In the rolled and annealed state these alloys behave similarly to unalloyed zirconium. In the alloys, selective oxidation of the more oxidizable element—i.e., zirconium—was noted. Copper tends to concentrate in the alloy in the immediate neighborhood of the metal-oxide interface and in this way generates a zone of Zr–Cu intermetallic compounds. Also pieces of metallic copper become engulfed in the surface layer of zirconia while the latter is growing. In comparison with unalloyed zirconium a slight slowing down of the dissolution of oxygen in the metal is evident. The apparent diffusion coefficient of oxygen in the oxide slightly increases. (tr-auth)

8116 STUDIES OF CORROSION OF ZIRCONIUM ALLOYS BY CARBON GAS. II. OXIDATION OF Zr–Nb ALLOYS. Guerlet, J. P.; Lehr, P. (Centre d'Etudes de Chimie Metallurgique, Vitry sur Seine, France). J. Nucl. Mater., 28: 165-76(Nov. 1968). (In French).

The oxidation of zirconium-niobium alloys in carbon dioxide has been studied at two temperatures, 750 and 900°C, for alloy compositions ranging from 1 to 20 wt. % of niobium. At 750°C the oxidation follows a linear kinetic law. The poor oxidation resistance of the alloys is attributed to the special morphology of the oxide films and their rapid degradation. At 900°C the oxidation rate progressively diminishes. The kinetic law for oxidation is intermediate between a cubic law and a parabolic law. The higher the niobium content in copper, the poorer is the oxidation resistance. Zirconium and niobium become oxidized simultaneously, which creates multi-phase oxide layers containing principally ZrO_2 and Nb_2O_5. To interpret the oxidation behavior of these alloys it is necessary to take into account the morphology of these oxide layers and also the structural modifications to which these alloys are subject as a consequence of the dissolution of oxygen in the metal. (tr-auth)

8117 INVESTIGATION OF THE OXIDATION RESISTANCE OF TUNGSTEN–NIOBIUM–TITANIUM ALLOYS. Lazareva, I. Yu.; Prokoshkin, D. A.; Vasil'eva, E. V.; Maslenkov, S. B. pp 280-5 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The oxidation resistance of binary tungsten alloys with up to 50% niobium or titanium, and ternary tungsten-niobium-titanium alloys has been investigated. Niobium was found to be the most effective in increasing the oxidation resistance, especially at contents of up to 30%. Titanium at contents of up to 5% improves the oxidation resistance of binary alloys. At higher contents the titanium effect is negative, especially at temperatures above 1200°C. Also in ternary alloys, the titanium effect is negative, especially at temperatures above 1200°C. Also in ternary alloys, the titanium effect is negative. Oxidation proceeds by a two-way diffusion of oxygen and metal with a preferred migration of niobium ions in the tungsten-niobium system and of titanium ions in the tungsten-titanium-niobium systems. (ATD)

8118 CORROSION RESISTANCE, ELECTROCHEMICAL AND MECHANICAL PROPERTIES, AND MICROSTRUCTURE OF NIOBIUM–TANTALUM ALLOYS. Andreeva, V. V.; Glukhova, A. I.; Dontsov, S. N.; Moiseeva, I. S.; Mel'nikova, L. V. pp 178-90 of Korroziya i Zashchita Konstruktsionnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A series of niobium-tantalum alloys were cast into ingots and some were forged into bars. To determine the temperature of recrystallization, some of the specimens were annealed for 2 hr at various temperatures. It was found that an increase in tantalum content increases the recrystallization temperature. In specimens containing about 1% tantalum, recrystallization started at 1100 and ended at 1200°C, while in those containing 30% tantalum it started at 1200 and ended at 1300°C. An increase in tantalum content also increases the strength and ductility of the alloys. An increase of tantalum content in forged specimens resulted in an increase in tensile strength and elongation. It was also found that the tensile and yield strengths of hot-forged specimens were considerably higher than those of specimens annealed at 1250°C for 2 hr indicating that there was not sufficient time for recrystallization during forging. Corrosion tests of niobium, tantalum and niobium-tantalum alloys were carried out in various solutions of sulfuric, hydrochloric and nitric acids. It was found that the corrosion rate of the alloys decreases with increased tantalum content. Alloys containing not less than 5% tantalum were found to be completely corrosion-resistant in a 20% solution of hydrochloric acid. This high corrosion-resistance of niobium-tantalum alloys is due to the presence of a protective film of mixed tantalum and niobium oxides, such as Ta_2O_5 and Nb_2O_5. (ATD)

8119 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF NIOBIUM–TITANIUM ALLOYS IN ALKALI SOLUTIONS AT ELEVATED TEMPERATURES. Glukhova, A. I.; Andreeva, V. V. pp 191-8 of Korroziya i Zashchita Konstruktsionnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Unalloyed niobium and titanium and Nb–Ti alloys containing 2

to 98% Ti have been tested for corrosion and electrochemical behavior in 20 to 40% KOH solutions at temperatures up to 100°C for time periods up to 100 hr. The results of corrosion tests show that the high corrosion rate of Nb–Ti alloys with a titanium content of less than 70% at 100°C is probably associated with the existence in these alloys of a second phase presently unidentified. In 20% KOH solution, the stationary potentials of alloys with a Ti content of up to 55% change slightly and have a value of about −1.050 V. With increasing titanium content, the stationary potentials of the alloys increase to −0.7 V in alloys with 60 to 80% Ti, and then again become more negative and reach a value of −0.9 V for unalloyed titanium. In 40% KOH, the stationary potentials of all alloys change slightly with increasing titanium content (from about −1.125 to −1.255 V). Niobium and the alloys with 10 and 20% Ti have a maximum corrosion rate of about 55, 58 and 95 g/m²hr, respectively, at a potential of −0.4 V. The alloys with 30 and 40% Ti had the highest corrosion rate, about 100 and 105 g/m²hr, over a wide (−0.4 to +2.0 V) range of potentials. This can probably be explained by the great heterogeneity of the structure of these alloys. Titanium and its alloy with 10% Nb corrode at a constant rate of 0.1 g/m² hr in the regions of both negative and positive potentials. (ATD)

8120 THE INTERACTION OF THE ALLOY NIOBIUM–25 TITANIUM WITH AIR, OXYGEN, AND NITROGEN. III. THE PRODUCTS OF THE Nb–Ti–N REACTION AT 1000°C. Felten, E. J. (United Aircraft Corp., Middletown, Conn.). J. Less-Common Metals, 17: 207-13(Feb. 1969).

Binary Nb–Ti alloys containing 5, 10, 15, 25, and 34 wt.% Ti were nitrided at 1000°C in 76 mm N_2. The nitrides formed in this process have been described previously in studies of the Nb–N and Ti–N binary systems; no ternary nitrides were observed. The reaction with nitrogen involves both bulk and grain boundary diffusion processes with the latter process becoming more important as the titanium content of the alloy is increased. The grain-boundary nitride phase is probably ϵ-Ti_3N. The reaction kinetics of the alloys are similar to those of niobium, titanium, and titanium alloys with nitrogen. (auth)

8121 THE INTERACTION OF THE ALLOY NIOBIUM–25 TITANIUM WITH AIR, OXYGEN, AND NITROGEN. I. THE UNUSUAL OXIDATION BEHAVIOR OF Nb–25 Ti AT 1000°C. Felten, E. J. (United Aircraft Corp., Middletown, Conn.). J. Less-Common Metals, 17: 185-97(Feb. 1969).

The oxidation behavior of Nb–25 wt.% Ti (39 at. % Ti) in air and oxygen at 1000°C has been studied. The oxidation kinetics are linear in air with a pressure dependence of approximately 0.4. In oxygen the kinetics are in agreement with the parabolic rate law about 8 h and are less dependent on the gas pressure. Oxidation in either air or oxygen results in the development of a unique substructure in the alloy. The external oxide layer at the alloy–oxide interface consists of TiO_2 and $Ti_2Nb_{10}O_{29}$. At the oxide-gas interface $TiNb_2O_7$ is observed formed by the solid state reaction of TiO_2 and $Ti_2Nb_{10}O_{29}$. Immediately below the external oxide layer, a gas-hardened zone consisting of two phases is observed. One of the phases is niobium-rich, the other is titanium-rich. The hardened zone is consistently thicker in specimens oxidized in oxygen than in air for equal exposure times. In either atmosphere, the growth of the hardened zone is diffusion controlled. Below the hardened zone, a small, but finite transition zone is observed followed by an extensive region containing a titanium oxide internal precipitate. The growth of this zone is also diffusion controlled, but the kinetics are complex since a portion of the zone is continuously being consumed by the inward growth of the gas-hardened zone. The oxidation behavior of the alloy, which is similar in some respects to that described by other investigators for Nb–Cr alloys, can be divided into two interrelated processes, dissolution of oxygen in the alloy and growth of an external scale. The poorer oxidation resistance of the alloy in air is assumed to be due to the interaction of nitrogen during the conversion of metal to external oxide. The substructure developed during exposure in air or oxygen is the same and is due to oxygen dissolution. (auth)

8122 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF SOME METALS AND ALLOYS SOLUTIONS OF HYDROCHLORIC ACID AT LOW TEMPERATURES. Kurtepov, M. M.; Volkova, T. V. pp 52-7 of Korroziya i Zashchita Konstruktsionnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A study was made to determine the limits of stable passivity of nickel–molybdenum alloys and several other metals characterized by high corrosion resistance in hydrochloric acid solutions. The study showed that the corrosion resistance of nickel–molybdenum alloys NIMO-28 and NIKhMO-20-10 increases considerably below OC and their dissolution at stationary potentials progresses slowly. The addition of chrome to nickel–molybdenum alloys increases their tendency toward passivity. At low temperatures, anodically polarized Kh23N28M3D3T and Kh18N12M3T steels have a wide range of passivity potentials in hydrochloric acid. At low temperatures, titanium and zirconium, just as tantalum, niobium, and molybdenum, are characterized by high corrosion resistance in 1 to 20% hydrochloric acid solutions. (ATD)

8123 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF RHENIUM. Tomashov, N. D.; Matveeva, T. V. pp 166-7 of Korroziya i Zashchita Konstruktsionnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Specimens of rhenium, sintered from 99.999%-pure electrolytic rhenium powder, were forged with intermediate annealing in vacuum at 2000°C and tested for electrochemical and corrosion behavior in H_2SO_4, H_3PO_4, KOH, HNO_3, and NaCl solutions of various concentrations at temperatures ranging from 25 to 100°C and for time periods up to 200 days. Corrosion tests were made on specimens fully submerged into solutions under conditions of natural aeration. In fully nonoxidizing media, e.g., distilled oxygen-free water, rhenium at 100°C had a very low corrosion rate (0.001 g/m² hr). In nonoxidizing acids (sulfuric, hydrochloric, phosphoric) of any concentration in the presence of air oxygen, the corrosion rate was less than 0.001 g/m² hr at 25°C and slightly higher, max 0.016 g/m² hr, at 100°C. Rhenium had a similar low corrosion rate, less than 0.001 g/m² hr, in distilled water with access to air oxygen at 25°C; but at 100°C, the corrosion rate was 0.05 g/m² hr, the same as that in 0.8 and 16% NaCl solutions at 100°C. Alkalies were found to be more reactive with rhenium than nonoxidizing acids; even at 25°C the rhenium dissolution rate in 3 and 10% KOH solutions was 0.015 g/m² hr. In oxidizing media (hydrogen peroxide solutions at a concentration higher than 0.05%; nitric acid solutions at a concentration higher than 10%) rhenium corroded readily; its corrosion rate in 40% nitric acid was about 200 g/m² hr and remained practically constant with further increases in the acid concentration. In the investigated solutions, rhenium corrosion has an electrochemical nature, and the corrosion behavior is determined entirely by the kinetics of the anodic and cathodic processes under the investigated conditions. Oxidizing solutions which ensure the effective course of cathodic depolarization shift the stationary potential of rhenium into the positive region (up to +1.0 V), which results in a high corrosion rate because of the overpassivation phenomenon. The passivation properties of rhenium are very weak. In nonoxidizing acids at the near-stationary potentials (up to +0.85 V) rhenium is passive (the anodic current is less than 0.001 mamp/cm²). In the same region of potentials (from 40.4 to +0.8 V), rhenium is passive to some extent also in NaCl and KOH solutions but at relatively high current densities. (ATD)

8124 STRUCTURAL CHANGES PRODUCED BY OXIDATION OF CHROMIUM–YTTRIUM ALLOYS. Kumok, L. M.; Larikov, L. N.; Maksimenko, E. A.; Yatsenko, T. K. (Inst. of Metal Physics, Kiev). pp 99-104 of Struktura Metallicheskikh Splavov. Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The oxidation behavior at 1100 to 1450°C of 99.9% pure chromium and chromium–yttrium alloys containing 0.5, 1.0, or 2.0% yttrium was studied. Yttrium improves the oxidation resistance of chromium and the oxidation rate of all the alloys tested, especially that of the alloy containing 0.5% yttrium, was much lower than that of pure chromium. On all the alloys tested, a dense tightly adhering oxide layer was formed, while the oxide layer on pure chromium peeled off easily. In pure chromium, a certain quantity of chromium oxides and nitrides was formed to a depth of 650 μ in a metal oxidized at 1450°C for 9 hr. In chromium–yttrium alloys, the amount of chromium oxides was much smaller and the nitrides were absent altogether. The penetration of oxygen and nitrogen into pure chromium proceeds mostly along the grain boundaries. This was not observed in the chromium–yttrium alloys. It is believed that yttrium improves the oxidation resistance of chromium primarily by a refining effect. (ATD)

8125 EFFECT OF RHENIUM ON THE LATTICE SOLID SOLUBILITY OF OXYGEN IN TUNGSTEN. Novick, D. T. (Alpha Metals, Jersey City); Machlin, E. S. Amer. Soc. Metals, Trans. Quart., 61: 777-83(1968).

Wires of tungsten, tungsten-1¼ at. % rhenium, and tungsten-3 at. % rhenium were equilibrated with respect to two different partial pressures of oxygen at 2100°C and quenched. A field ion microscope study of specimens prepared from these wires revealed that, for each alloy, the increment in bright-spot concentration in the [110]-[211]-[121] triangle was proportional to the increment found in pure tungsten and further, for equilibration with respect to the same partial pressure of oxygen, the increment in bright-spot concentration was proportional to the increment in rhenium concentration. These results have a simple interpretation in terms of the equilibrium between oxygen, rhenium and rhenium–oxygen (Re–O) clusters in the solid solution.

A minimum binding free energy for the Re–O cluster of 0.9 eV was calculated. The scavenging of oxygen from dislocation and grain boundary sites by rhenium in solid solution in tungsten appears probable and this action is believed to be the basis of the increment in ductility known to be associated with the addition of rhenium to tungsten. (auth)

8126 THE INTERACTION OF THE ALLOY NIOBIUM–25 TITANIUM WITH AIR, OXYGEN, AND NITROGEN. II. THE REACTION OF Nb–25Ti IN AIR AND OXYGEN BETWEEN 650° AND 1000°C. Felten, E. J. (United Aircraft Corp., Middletown, Conn.). J. Less-Common Metals, 17: 199–206(Feb. 1969).

The oxidation behavior of Nb–25 wt % Ti (39 at. % Ti) in air and oxygen between 650 and 1000°C has been studied. Below 800°C the alloy oxidizes in agreement with the parabolic rate law in either air or oxygen. The activation energy for the process, i.e., the dissolution of oxygen into the alloy, is 19.5 kcal mol^{-1}. Between 650 and 800°C little or no external oxide product is formed except after extended exposure. The nitrogen component of the air plays only a very minor role in the oxidation process. Above 800°C, the oxidation behavior of the alloy is markedly different in air and oxygen. The kinetics are approximately linear in air and parabolic in oxygen. The activation energies for these processes are 38 and 76 kcal mol^{-1}, respectively. Between 800 and 1000°C the presence of nitrogen in the oxidizing atmosphere exerts a strong effect on the oxidation kinetics. (auth)

Preparation and Fabrication

Refer also to abstracts 7699, 8111, 8161, 8165, 8167, 8177, 8187, 8216, 8231, 8269, and 9265.

8127 (BMI-RI-7211) COLUMBIUM AND TANTALUM ALLOY DEVELOPMENT. Babitzke, Herbert R.; Oden, Laurance L.; Kelly, Hal J. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Dec. 1968. 12p.

As part of a project to develop refractory metal alloys suitable for high-temperature structural applications, the Bureau of Mines applied solid solution and precipitation-hardening techniques to Nb and Ta alloys. Thirty-three alloys were evaluated to determine their formability, strength, and oxidation resistance. Three alloys had tensile strengths near 40,000 psi at 1,200°C: Nb-1N-5W-5V-10Hf (No. 4), Nb-15Hf-5W-0.5B (No. 31), and Nb-15Hf-5W-1B (No. 32). Oxidation resistance of the high-strength alloys was good. Alloy 4 gained only 34 mg/cm^2 at 1,200°C, and 21 mg/cm^2 at 1,000°C in 2 hours. Hot forming was done without any protection from oxidation. (auth)

8128 (CONF-681020–(Vol.2), pp 485–98) PREPARATION OF RARE EARTH AND YTTRIUM METALS BY ELECTRODEPOSITION AND VACUUM DISTILLATION OF ALLOYS. Morrice, E.; Murphy, J. E.; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center).

Gadolinium, dysprosium, and yttrium are difficult to electrowin as high-purity liquid metals because of their high melting points (>1,300°C). Samarium metal is difficult to prepare directly by electrolysis because the metal reacts with the electrolyte. In this study, the rare earth metal was electrodeposited on a solid manganese, chromium, or iron cathode to form a low-melting alloy. The alloy was then vacuum distilled to yield the rare earth metal. A typical samarium metal product, obtained as the distillate from vacuum distillation of a samarium–iron alloy, contained 150 ppM oxygen, 80 ppM carbon, and 50 ppM iron as impurities. Gadolinium metal, obtained as a residue from the distillation of a gadolinium–chromium alloy, contained in ppM, 300 oxygen, 200 carbon, and less than 100 chromium. (auth)

8129 (EUR-3663) MASURCA PLUTONIUM FUEL ELEMENTS FABRICATION. Lesser, R.; Gueugnon, J. F.; Maurice, M.; Vaane, J. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Oct. 1968. 294p. Dep.

2115 Masurca fuel elements containing 175 kg plutonium were fabricated. Two sorts of plutonium metal were used, containing 8.4 and 3.8 % ^{240}Pu respectively. The elements were required to be 101.6 and 203.2 mm long and have an outer diameter of 12.7 mm. Each element consists of a fine steel can and a core of a plutonium alloy with depleted uranium and a little iron. The composition of the quality with 8.4 % ^{240}Pu is 25 wt % Pu, 1 wt % Fe and 74 wt % U, and of the quality with 3.8 % ^{240}Pu 24 wt % Pu, 1 wt % Fe and 75 wt % U. The original metals were first melted together in a vacuum-induction furnace, then cast in rod form in a centrigugal furnace, the rods were machined on a lathe and placed in cans plugged at one end. After decontamination of the open end, insertion of the second plug and welding with an electron beam unit, various inspections were carried out including a leaktightness inspection with a helitest apparatus and a check on the fissile material by spontaneous neutron counting. The finished elements met the specifications. Plutonium losses were about 0.1% of the quantity used. (auth)

8130 (LA-DC-10008) TECHNIQUE FOR THE METALLOGRAPHIC PREPARATION OF METALLIC SODIUM. Bender, J. H. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 10p. (CONF-681107-1). Dep. CFSTI.

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo.

A technique for the metallographic preparation of metallic sodium is described. This includes mounting the sodium in a low-melting alloy, deep freezing the specimen and mount in liquid nitrogen, grinding, polishing and experimental etching procedures, and the photomicrography of the specimen utilizing a portable helium chamber with an optical glass viewport. (auth)

8131 (ORNL-4370, pp 68–75) TUNGSTEN METALLURGY. Harms, W. O. (Oak Ridge National Lab., Tenn.).

Billets of W and W-base alloys were extruded as primary and duplex extrusions in the form of tube shells, round bars, and sheet bar. Extrusion temperatures ranged from 1650 to 1870°C and extrusion ratios varied from 3.6 to 9.6. Modifications of die design increased the life of the ZrO_2-coated extrusion dies. A petroleum-base lubricant was superior to glass for lubrication at temperatures above 1000°C. Unalloyed W bar stock was successfully reduced 25% per pass at 1200°C and W-30% Re-30% Mo(at%) was successfully reduced 30% in three passes at 1050°C without intermediate anneals. Chemical vapor deposition (CVD) studies were made of W and W–Re alloys. The surface concentration of WF_6 was the controlling factor in deposit morphology. Orientation studies indicate that the {110} orientation desired for thermionic applications can be produced from WF_6 under certain conditions. Gas bubbles less than 400 Å in diameter, fluorine impurity clusters, or both, were responsible for retarding crystallization in rolled CVD W containing 25 ppM F. Creep-rupture studies for 1000 hr showed that at 1650°C the creep and rupture strengths of W and its alloys decreased in the order, W-5% Re, W-25% Re,W, W-25% Re-30% Mo (at%). At 2200°C the W-5% Re, and W-25% Re alloys are equivalent and slightly stronger than W. Successful TIG welding of 1/16 in.-thick unalloyed W sheet required preheating to at least 150°C. The ductile-to-brittle transition temperature for welds in powder-metallurgy-derived W was about 200°C higher than for unwelded material. No sigma phase was detected in W-26% Re weld metal deposited on unalloyed W sheet. (auth)

8132 (ORNL-4370, pp 92–100) MATERIALS DEVELOPMENT FOR ISOTOPIC POWER SOURCES. Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

Support of isotopic power programs included work on general technology and uses of ^{244}Cm and ^{90}Sr in SNAP-21 and SNAP-23. In the Curium Program components for 3-in. dia vented and 4-in. dia nonvented capsules were extruded from arc-cast W. Chemical vapor deposition (CVD) of W was evaluated as a possible cladding technique for Cm fuels. A model was developed for predicting creep behavior of a capsule fueled with an alpha-emitting isotope such as ^{244}Cm. Brazing alloys based on Pt and refractory metals are being developed for joining Cm-fueled capsules to thermionic emitters. Several alloys with brazing temperatures in the range 1900 to 2300°C exhibit good wetting and flow characteristics. To aid in assessing the heat transfer characteristics of T-111 as a candidate cladding material, the electrical resistivity, specific heat, and total hemispherical emittance were determined in the range of 300 to 1700°K. Anomalously low values were determined for electrical resistivity, and an instability in the total hemispherical emittance was also detected. In the Strontium Program the compatibility of Sr fuels with alloys was assessed and the welding characteristics of these alloys determined. Nonradioactive compounds of $SrTiO_3$, Sr_2TiO_4, and SrO were tested for compatibility with Hastelloy C, type 316 stainless steel, and Haynes alloy No. 25 for 1000 hr at 1100°C. The most inert compound was Sr_2TiO_4. Type 304 stainless steel was found to be a good stand-in for Hastelloy C in welding studies. Weld penetrations of up to 0.180 in. were obtained on both materials with the gas tungsten-arc process. Welding and inspection procedures were developed for SNAP-21 fuel capsules. Electron-beam parameters were optimized for weld penetration and inspectability. Capsule components were ultrasonically inspected on a specially constructed scanning device, and in-cell inspection was successfully completed on two welded fuel-containing capsules. Electron-beam welding procedures are being developed for sealing SNAP-23 fuel capsules. Initial studies resulted in acceptable welds on unpreheated capsules, but modifications will be required for fuel-containing capsules. (auth)

8133 (ORNL–4370, pp 133–41) SINTERED ALUMINUM PRODUCTS DEVELOPMENT. Martin, W. R. (Oak Ridge National Lab., Tenn.).

A billet fabrication process to produce SAP having uniform properties was developed and an examination made of causes and possible means of improving the low creep ductility of SAP without sacrificing strength. The fabrication process was evaluated on a small pilot plant scale. The properties within a particular billet made by this process are uniform; the maximum range of strength observed is 2% of the mean. This SAP is approximately 20% stronger at 450°C than commercial SAP of equivalent oxide content. Several nondestructive test methods were developed to determine the flake thickness and oxide content of ball-milled flake. SAP billets were scanned using an x-ray attenuation method and calibration curves were established. With this technique a 0.2% change in density or thickness of billet can be detected and used for process quality control. Secondary working studies showed that the structure and properties of SAP can be improved by hot-working. The fracture of SAP from −200 to 450°C was studied by electron microscopy. Three modes of fracture have been identified: separation, tearing, and shearing. All three show features characteristic of ductile failure even though the uniform elongations are often less than 1%. (auth)

8134 (ORNL–4370, pp 238–40) DISPERSION STRENGTHENING OF ALUMINUM-BASE ALLOYS. Hammond, Joseph P. (Oak Ridge National Lab., Tenn.).

The technical feasibility of a method of dispersion hardening Al by the fine particle embedment principle was demonstrated. One such alloy was significantly stronger at 450°C than a conventional SAP with 11% Al_2O_3, yet it contained only 4% oxide. Another alloy showed improved low-strain-rate fracture ductility with good strength when compared to SAP to 450°C. (auth)

8135 (UJV–2055-M) EFFECT OF NEUTRON IRRADIATION ON MECHANICAL PROPERTIES OF WELDING A-2 AND SOME MANGANESE–NICKEL–MOLYBDENUM STEELS. Vacek, M.; Juricka, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1968. 42p. (In Czech). Dep.

The radiation embrittlement and hardening of two welding metals from the low-alloy-steel and seven different heats of Mn–Ni–Mo steels have been studied. The welding joints produced by two types of welding processes namely semi-automatized arc weld in the CO_2 atmospheres and electroslag weld have been investigated. The effect of different killing elements (Al, Nb, Ti, V, Zr) and various content of nickel or manganese on radiation embrittlement and hardening have been studied for experimental Mn–Ni–Mo heats. One heat was evacuated before casting. The neutron doses ranged from 7.10^{18} to 10.10^{18} n/cm^2 (E > 1 MeV) and temperature ranged from 60 to 120°C. A part of the irradiated tensile specimens of welding metals and experimental heats was annealed 1 hr at 350°C on the recovery after irradiation. The recovery was various for different steels. Both welding metals showed roughly the same increase of the transition temperature ΔTT. The least increase of the transition temperature ΔTT for experimental heats was found for heats with the highest content of Ni (3,07% and 2,12%) and for the heat, which was evacuated before casting. Results are incomplete as to the efficiency or priority of killing elements from the point of view of the radiation damage. (auth)

8136 EFFECTS OF ECM ON SURFACE INTEGRITY. Bellows, Guy (General Electric Co., West Lynn, Mass.). Tool Mfg. Eng., 61: 66-9(Sept. 1968).

The effects of electrochemical machining on the structure of machined parts are studied. The effects of high current densities, and the kind of electrolyte and hydraulic energy involved are examined. The intergranular and selective attack which can be caused by inappropriate electrolyte or machining conditions is discussed. Good electrolyte flow and control over current densities ensure successful machining. The machining of titanium, beryllium, and refractory alloys is described. (IAA)

8137 ELECTRON BEAM WELDING OF COPPER TO MOLYBDENUM, TANTALUM, AND KH18N10T STEEL. Terebichi, G. W. Weld. Prod. (USSR) (Engl. Transl.), 14: 14-16(Oct. 1967). Translated from Svar. Proizv., 14: 8-9(Oct. 1967).

The possibility of electron-beam welding of dissimilar metals such as copper to molybdenum, tantalum, and 18 Cr-10 Ni stainless steel is examined. It is found that copper wets the surface of molybdenum and tantalum well. In electron beam welding of copper to stainless steel there is no penetration of the copper along the grain boundaries of the steel. (IAA)

8138 HIGH TEMPERATURE BRAZING ALLOYS FOR TUNGSTEN AND TANTALUM. (to United States Atomic Energy Commission). British Patent 1,136,980. Dec. 18, 1968. Priority date Oct. 22, 1965, United States.

A high temperature brazing alloy for tantalum, tungsten, and their alloys is described. The brazing alloy consists of 35 to 45 wt % iridium and the remainder tungsten. Rhenium may be substituted for 1 to 10 wt % of tungsten. (F.S.)

8139 SYNTHESIS OF GERMANIDES OF TITANIUM, ZIRCONIUM, AND HAFNIUM AND INVESTIGATION OF CERTAIN OF THEIR PROPERTIES. Bondarev, V. N.; Podergin, V. A.; Perminov, V. P. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1689-93(Oct. 1968). (In Russian).

Optimum conditions for obtaining germanides of the IVA Subgroup in the Periodic Table were determined. It was established that it is possible to obtain germanides of Ti, Zr, and Hf of different composition by sintering previously pressed stoichiometric mixtures of metal powders or by the method of hot pressing at comparatively low temperatures (900 to 1000°C). Residual porosity of products obtained by these methods was 20 to 50%. Conditions were investigated for obtaining compact forms of the germanides by hot pressing using boron nitrode to line the graphite mold. It was established that the sintering temperatures for Ti, Zr, and Hf germanides (except $TiGe_2$ and $HfGe_2$) lie in the range from 1300 to 1750°C. Maximum density of the compact forms was 90 to 95% theoretical. Microsolidities, specific resistances, densities and melting points of the germanides were measured. (tr-auth)

8140 PURE METALS. Langeron, J.-P. (CNRS, Vitry-sur-Seine, France). Vide, No. 136, 220-8(July-Aug. 1968). (In French).

A bibliographic review is given of the principal methods for the production of pure metals. Electrolysis, thermal decomposition, and reduction are the three main procedures used in the production of metals, and the problems inherent in each process are briefly summarized. The purification under vacuum corresponds to two distinct needs: to avoid the pollution by the atmosphere in contact with the metal and to obtain a certain purification. The formulas expressing these competing processes are given. Purification by action of a chemically active gas such as hydrogen is then considered. Purification by segregation by electro-transport, zone fusion, and zone transformation is discussed. The effect of purity on the physical properties of the metals is considered. (J.S.R.)

8141 PLUTONIUM FUEL DEVELOPMENT FOR FAST REACTORS IN THE UNITED STATES. Kittel, J. H. (Argonne National Lab., Ill.); Kelman, L. R.; Handwerk, J. H.; Zebroski, E. L.; Bailv, W. E.; Strasser, A. Met. Soc. Conf., 42: 311-27 (1966).

The review of development of ceramic fuels for fast reactors, in the U. S., is focused on uranium–plutonium oxides, carbides, and alloys, and includes discussions on synthesis and preparation of fuels, physical properties, design of fuel elements, and in-reactor behavior. (P.G.C.)

8142 AUSFORMING OF 18 Ni–Co–Mo STEEL. Yasunaka, Takashi (National Research Inst. for Metals, Tokyo); Araki, Toru; Watanabe, Satoshi. Nippon Kinzoku Gakkaishi, 32: 1008-12(1968). (In Japanese).

Ausforming was applied to 18 Ni–Co–Mo steels containing 0.002 to 0.1% C. Effects of ausforming on the aging behavior, mechanical properties, and microstructure with thin foil and extrusion replica electron microscopy were studied. Disc-shaped precipitates in overaged low C alloys had a structure close to that of Ni_3Mo. Ausforming accelerated age hardening and precipitation of Mo_2C, but diminished the strength increment due to aging. In fully aged alloys, increase in 0.2% yield strength by ausforming was increased with C content but the trend gradually saturated beyond 0.05% C. The increasing rate of yield strength of the aged 0.1% C alloy was 0.39 kg/mm^2/% reduction above 17% reduction in thickness. The strength of the present alloys ausformed and fully aged can be explained by the combination of ordinary strengthening and the decreased age hardening by ausforming, the primary cause of the former being the increase of dislocation density in martensite. (auth)

8143 INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF MOLYBDENUM–COLUMBIUM ALLOYS IN THE SINGLE CRYSTAL STATE. Savitskii, E. M.; Burkhanov, G. S.; Bokareva, N. N. (Moscow Inst. of Metallurgy). pp 297-303 of Rost i Nesovershenstva Metallicheskikh Kristallov. Kiev, Naukova Dumka, 1966. (In Russian).

The purpose of the investigation was to obtain single crystals of alloys of refractory metals free from interstitial impurities that reduce the ductility of the metal. The system Mo–Nb was chosen in various Mo–Nb ratios, from pure molybdenum to pure niobium. The starting materials for preparation of the alloys were vacuum melted rods of molybdenum and niobium, which were melted to-

gether in the apparatus for zone melting by electron beams. The single crystals of the alloys were obtained by two passes of the molten zone made in both directions; the last pass was away from the original Mo–Nb rods. Only by using single crystals of Mo and Nb was it possible to obtain single crystals of alloys with a high concentration of the second component. The change in hardness and electroresistance was a function of the composition, similar to that in polycrystalline alloys; the hardness was greatest at the 50-50 composition. X-ray diffraction analysis disclosed a mosaic structure of the single crystal alloys. (ATD)

8144 GROWING SINGLE CRYSTALS OF RHENIUM BY ZONE MELTING WITH AN ELECTRON BEAM. Pikunov, M. V.; Koroleva, N. P.; Marunova, K. V.; Pavlova, E. I. pp 157-63 of Rost i Nesovershenstva Metallicheskikh Kristallov. Kiev, Naukova Dumka, 1966. (In Russian).

The effects of composition of the starting material, and of the speed and number of passes, on the quality and purity of single crystals of rhenium obtained by zone melting with an electron beam were studied. The total amount of impurities (some 26 elements), originally about 2×10^{-2}%, was reduced after three or four passes to about 3×10^{-3}%, the limit of detectability. The atmosphere (vacuum or hydrogen) had little effect on purification. No direct connection was found between the degree of purification and the vapor pressure of the impurities. After two or three passes, the rhenium rods became single crystals. Their microstructure and preferential direction of growth were investigated by electropolishing and subsequent x-ray diffraction. The microhardness in different planes was also investigated. (ATD)

8145 APPLICATIONS OF INDUSTRIAL MATERIALS FOR NUCLEAR POWER, AND DOMESTIC PRODUCTION OF NUCLEAR FUELS. Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Tokyo); Matsukuma, Kazuma. Kogyo Rea Metaru, No. 38, 45-53(Apr. 1968). (In Japanese).

Applications of industrial materials for nuclear power e.g., nuclear fuels, moderators, control materials, coolants, structural materials and classing materials are described. Domestic production of nuclear fuels, the establishment of nuclear fuel cycles (nuclear fuel processing, uranium enrichment, fuel fabrication, uses of domestic fuels, and cladding fabrication), and spent fuel reprocessing are discussed. (NSA of Japan)

8146 PRODUCTION AND PROPERTIES OF SINGLE CRYSTALS OF REFRACTORY METALS AND ALLOYS. Savitskii, E. M.; Burkhanov, G. S.; Kopetskii, Ch. V.; Bokareva, N. N.; Kardashevskaya, V. G. pp 15-24 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The two main methods for production of metallic single crystals are extraction from a melt by the recrystallization method and zone refining. The method of extraction from a melt by seeding is widely employed industrially for growing large single crystals of germanium, silicon (up to 80 mm in diameter), and semiconductor compounds of varying composition for diodes, transistors, and condensers. Application of this method to refractory metals has not been widely developed. The techniques of zone refining are described in detail. In vertical zone melting without a crucible, the ratio of the surface tension to the density of the melt should be 100:1 or greater. The maximum size of single crystal rods produced by this method is for example, 14 to 16 mm for molybdenum and 6 to 8 mm for tungsten, with a length of the order of 200 or 250 up to 500 mm. The purity and mechanical properties of rhenium of different degrees of purity, including the mechanical properties under elongation stress, the hardness, and the temperature of the start of recrystallization are tabulated. The mechanical properties of single crystals of various alloys of the refractory metals are also given. It is found that an increase in the purity of zone refined molybdenum considerably lowers its resistance to deformation. Based on experimental results, a series of figures illustrate the substructure of single crystalline alloys, the mechanical properties of single crystal alloys of the molybdenum–niobium system, and the microhardness of alloys of the molybdenum–niobium system. (ATD)

8147 IMPROVED URANIUM-BASED ALLOYS EMPLOYED AS FUEL ELEMENTS IN NUCLEAR REACTORS AND PROCESS FOR MAKING SAME. (to SNAM SpA). British Patent 1,138,949. Jan. 1, 1969. Priority date Jan. 19, 1965, Italy.

A process is described for producing a Cr–Nb–U alloy for use as a reactor fuel. The alloy is cooled from a temperature at which the γ-phase U is stable, at a cooling rate from 300 to 50°C per min. The alloy is then heated to a temperature at which the β-phase U is stable. The alloy is kept at this temperature for not more than 3 hr. The β-phase alloy is cooled at room temperature at a rate of 400 to 4°C/min; subsequently the alloy is reheated to a temperature at which the α-phase is stable. The hardness ratings are higher than those for pure U. (F.S.)

Properties Evaluations

Refer also to abstracts 8111, 8118, 8127, 8131, 8132, 8143, 8146, 8216, 8231, 8539, 8667, 9117, 9118, and 9237.

8148 (BMI-X-10246) REFRACTORY-METAL THERMOCOUPLES IN NUCLEAR AND HIGH-TEMPERATURE APPLICATIONS. Droege, John W.; Miller, Neil E.; Schimek, Marcus E.; Wood, Van E.; Ward, James J. (Battelle Memorial Inst., Columbus, Ohio). Nov. 22, 1968. Contract W-7405-eng-92. 39p. Dep. CFSTI.

The performance of platinum, tungsten, tungsten-rhenium alloys, and molybdenum-rhenium alloys in thermocouples in nuclear reactor and high-temperature environments was investigated, using BeO, ThO_2, and Y_2O_3 as insulators and tantalum, niobium, and molybdenum as sheaths. Upon irradiation of thermoelement wires at 50°C both transmutation and displacement effects were found, although displacement damage showed signs of annealing out during testing at 1000°C. Transmutation effects, due mainly to the production of osmium from rhenium were small, and are probably insignificant except in long-term use. Thermodynamic analyses were made for various sheath-insulator systems suggested for use at 2200°K. On the basis of contained vapors of reaction products all showed promise. However, when mass transport was included in the considerations, molybdenum, tungsten, rhenium, and alloys of these projected better sheath properties than niobium and tantalum, and ThO_2 and Y_2O_3 projected better insulator properties than BeO. Tests of thermal stability of thermal emf over long periods at 1800 and 2000°K showed that BeO, ThO_2, and Y_2O_3 were all satisfactory insulators; however, the BeO must be of high purity. As predicted thermodynamically, tantalum and niobium were inferior to molybdenum as sheaths; tungsten-3 wt % rhenium, tungsten-25 wt % rhenium, and molybdenum-50 wt % rhenium all proved satisfactory as thermoelement wires. It was found that a high-vacuum environment is not necessary for successful thermocouple operation at 1800 to 2000°C; an argon atmosphere was used successfully, and small quantities of water vapor were found tolerable. (auth)

8149 (BNL-50137) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 6, Number 4. (Brookhaven National Lab., Upton, N. Y.). Aug. 1968. 31p. Dep. CFSTI.

Eleven reviews are presented of current topical and progress reports in the field of high-temperature liquid-metal technology. The reviews cover: materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems. The reports reviewed are from research programs for the development of fast breeder reactors and power systems for space vehicles. (D.L.C.)

8150 (BNWL-SA-1959-A) CREEP OF ZIRCONIUM FROM 50 TO 850 C. Gilbert, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 14, 1968. Contract AT(45-1)-1830. 28p. (CONF-681105-4). Dep. CFSTI.

From Application-Related Phenomenon of Zirconium and Hafnium Symposium, Philadelphia, Pa.

Uniaxial creep tests have been conducted on polycrystalline alpha zirconium from 50 to 850°C to evaluate the stress and temperature dependence of the second-stage creep rate. Five domains of creep behavior were observed over this temperature range. From 50 to 300°C, the activation energy for creep was stress-dependent, increasing from approximately 30 to 75 kcal/mole when the stress was decreased from 800 to 400 kg/cm^2. Between 300 and 400°C, the activation energy is approximately 70 kcal/mole. From 400 to 500°C, the activation energy increased from 70 to 105 kcal/mole with decreasing stress. From 500 to 700°C, the activation energy was lower with an average value of 67 kcal/mole which was independent of stress and temperature. From 700 to 800°C, the activation energy was 100 kcal/mole, independent of stress. The apparent activation energy decreased to a very low value above 800°C. This apparent decrease in the activation energy is caused by a structural instability which may be related to the alpha-to-beta phase transformation. The creep behavior was somewhat different depending upon whether the specimen was obtained from material fabricated and heat-treated in the alpha phase or heat-treated in the beta phase. The various mechanisms controlling the creep behavior in these domains are discussed. The high-temperature activation energies of 100 and 67 kcal/mole are similar to those observed in other hcp metals when compared on a

homologous temperature basis. The low-temperature creep behavior is analogous in some respects to creep in zirconium-base alloys Zircaloy-2 and Zr–2.5 Nb which are used for pressure tubes and fuel cladding in water-cooled nuclear reactors. (auth)

8151 (CEA-R-3577) SURVEY OF THE CHEMICAL DIFFUSION AT INFINITE DILUTION IN THE NICKEL–PLUTONIUM AND ALUMINIUM–URANIUM SYSTEMS. Blechet, Jean-Jack (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 98p. (In French). Dep.

Solubility S_0 and chemical diffusion coefficients $\tilde{D}_{PuNi}$ at infinite dilution of plutonium in nickel were determined by autoradiography in polyphase systems by the welded couples method. S_0 varies from 40 to 80×10^{-6} (atomic concentration) and $\tilde{D}_{PuNi}$ follows an ARRHENIUS law: $\tilde{D} = D_0 \exp - Q/RT$ with $0.03\ cm^2/s < D_0 < 1.6\ cm^2/s$ and $46{,}000\ cal/mole < Q < 56{,}000\ cal/mole$. Diffusion of uranium in aluminum were carried out by fissiography using the thin-layer method. Frequency factors lie between 0.01 and 3.1 cm^2/s and the activation energy lies between 24,000 and 34,000 cal/mole. (auth)

8152 (CEND-3742-344) VANADIUM PURIFICATION. Eighth Quarterly Progress Report, July 1–September 30, 1968. La Vake, J. C.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Nov. 1968. Contract AT(30-1)-3742. 16p. Dep. CFSTI.

The second batch of V-15Cr-5Ti sheet was fabricated, making a total of 45.6 pounds of sheet produced. The alloy ingot for use at Argonne National Laboratory was shipped, completing the material production phase of the program. Tensile testing of the recrystallized sheet is complete along with eight stress rupture tests. The material gives typical curves for time-to-rupture and minimum-creep-rate properties. (auth)

8153 (CONF-681020–(Vol.1), pp 175-86) YTTRIUM–SAMARIUM SYSTEM. Lundin, C. E.; Yamamoto, A. S. (Denver Research Inst., Colo.).

Structural and thermodynamic characteristics of the Y-Sm system were determined. The principal experimental technique employed was Knudsen-effusion analysis of vapors over a series of Y-Sm alloys in the temperature range of 1073 to 1423°K. Auxiliary techniques included metallographic analysis, thermal analysis, x-ray diffraction analysis, and density measurement. The phase equilibria were established collectively as a result of these analyses to consist of complete miscibility both in the solid state and liquid state. Thermodynamic activities of samarium in the low-temperature allotrope were calculated at 1173°K from vapor-pressure data obtained in the Knudsen-effusion studies Plots of activities of experimentally determined samarium-in-yttrium and calculated yttrium-in-samarium are presented. The system exhibits rather extensive negative deviation from ideality. This is attributed to the crystal structure differences between the two components. From these data, free energies, enthalpies, and entropies of mixing were calculated and presented both tabularly and graphically. The excess free energy values are negative, the excess enthalpies are positive, and the excess entropies are positive. The structure as determined by x-ray diffraction analysis in the low-temperature allotrope changes abruptly from a stacking sequence of Mg(A3) type to Sm-type at about 80% Sm. Metallographically, the transition is observed by a corresponding change in microstructure. The positive maxima of both enthalpy and entropy curves are also seen to be coincident with the above observations. It is postulated that the maxima are brought about by strain due to mismatch of the component metal lattices. (auth)

8154 (CONF-681020–(Vol.1), pp 221-31) CALORIMETRIC MEASUREMENT OF THE HEAT OF SOLUTION OF SAMARIUM IN TIN. DETERMINATION OF THE HEAT OF FORMATION FOR DEFINITE COMPOUNDS IN THE TIN–SAMARIUM SYSTEM. Percheron, Annick; Mathieu, Jean-Claude (Centre National de la Recherche Scientifique, Bellevue (France). Laboratorie des Terres Rares).

Three definite compounds, $SmSn_3$, Sm_2Sn_3, Sm_3Sn_5, were found in the Sm–Sn system by thermal and x-ray analyses. By measuring the heats of formation the hypotheses of strong atomic interactions between tin and samarium was tested. In the first stage, the heat of solution of samarium in tin was measured at 967°K in a liquid tin bath calorimeter. It was possible to measure the partial enthalpy of samarium, which can be expressed, through the concentration range studied ($0 < X_{Sm} < 5.10^{-3}$) by the equation: $\Delta H_{Sm} = -45.6 + 818\ X_{Sm}$ (kcal/g at.). Measurements of the heats of solution of definite compounds in the tin-samarium system were carried out. Taking into account the partial enthalpy of samarium the following heats of formation at 295°K were derived and expressed in kcal/mole $-\Delta H_f$ ($SmSn_3$) = 53.8; ΔH_f (Sm_2Sn_3) = – 86.9; and ΔH_f (Sm_3Sn_5) = – 121.7. These values give an indication on the relative stability of the compounds. A curve can be drawn showing the change in enthalpy of mixing in the system tin–samarium versus the concentration ($0 < X_{Sm} < 1$) at 295°K. (auth)

8155 (CONF-681020–(Vol.1), pp 237-50) ANOMALOUS EFFECTS OF TEMPERATURE AND IMPURITIES ON THE ELASTIC MODULI OF SCANDIUM SINGLE CRYSTALS. Fisher, E. S.; Dever, D. (Argonne National Lab., Ill.).

A study of the temperature dependence of the elastic moduli of scandium metal single crystals between 4 and 298°K revealed two unusual properties of scandium: the velocities of ultrasonic waves (longitudinal and transverse) propagated parallel to the hexagonal axis increased with increasing temperature and the magnitude and temperature dependence of the c_{33} modulus (calculated from the longitudinal wave velocity parallel to the hexagonal axis) were remarkably sensitive to the impurity content of the metal. The studies were carried out with single crystals made from 5 different grades of metal, each containing less than 2000 ppM total impurities. The anomaly in the temperature dependence of c_{33} appeared to decrease in degree as the quantity of thorium impurity was increased from 10 to 500 ppM by weight, whereas additions of gadolinium up to 200 ppM had no significant effect. The unusual temperature and impurity effects appeared consistent with a deformation potential model, where the electron band structure of scandium is extremely sensitive to nonmagnetic heavy element impurities but relatively insensitive to ferromagnetic impurities. (auth)

8156 (EUR–4053) GAMMA PHASE URANIUM–MOLYBDENUM FUEL ALLOYS. Beghi, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 22, 1968. 82p. Dep.

Information on the gamma phase uranium–molybdenum alloys, mainly the U-10 wt % Mo alloy, are summarized. Characteristics reported include gamma stability as shown by thermal transformation kinetics (TTT diagrams) of the metastable gamma phase; dimensional stability under thermal cycling and under irradiation induced phase reversal and swelling; and physical and mechanical properties. (auth)

8157 (GEMP–640) CREEP FAILURE MODES IN ARC-CAST AND POWDER METALLURGY TUNGSTEN. Rau, R. C.; Williams, F. T. Jr. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). [1967]. Contract AT(40-1)-2847. 15p. (CONF-681107-2). Dep. CFSTI.

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo.

Microstructural investigations, using optical and replica electron microscopy, have been used to characterize the modes of high temperature creep deformation and failure in high purity arc-cast and powder metallurgy tungsten. These observations indicate that whereas arc-cast material deforms in a ductile fashion and fails transgranularly, powder metallurgy material is relatively brittle and fails intergranularly by the formation and link-up of creep cavities. At lower temperatures (<2000°C) these cavities were irregular in shape and tended to be flattened along the grain boundaries, while at higher temperatures the cavities exhibited polyhedral shapes. Measurements of the creep porosity present in the powder metallurgy samples accounted for approximately 16% of their total deformation. Although these studies failed to show any evidence of precipitation which might explain the basic difference in failure mechanisms of the two types of tungsten, the occurrence of sintering pores in the powder metallurgy material probably contributes to its embrittlement. (auth)

8158 (ORNL–4370, pp 5-8) DEFORMATION AND ANNEALING OF METALS. McHargue, Carl J. (Oak Ridge National Lab., Tenn.).

In cold-rolled Nb were found important texture components not predictable from present theory. Certain fabricating conditions produced a sharp surface texture and a zone at intermediate depths that lacked some of the texture components typical of body-centered cubic metals. These texture inhomogeneities were analyzed in terms of stress states existing at various fabrication stages. It was found that in cold-rolled Cu_3Au the texture developed depended upon the amount of order present at each stage of deformation and that both copper-type and brass-type textures could be produced. The recovery kinetics of deformed Nb and Nb–V alloys are being analyzed in terms of dislocation behavior. (auth)

8159 (ORNL–4370, pp 13-15) DIFFUSION IN SOLIDS. Lundy, T. S. (Oak Ridge National Lab., Tenn.).

Tracer lattice diffusion coefficients in monocrystalline W were measured with high precision over a range of 1400 to 2400°C.

Short-circuiting phenomena became dominant at lower temperatures and are being investigated in detail. The alpha-energy degradation method was used to investigate diffusion in UO_2 and UN. It was found that previous measurements on cation self-diffusion in UO_2 were characteristic of grain-boundary diffusion and not lattice diffusion and that published diffusion coefficients are in error by at least two or three orders of magnitude. Data on Ti diffusion in Ti modified Hastelloy N over the temperature range of 800 to 1250°C were obtained by serial sectioning involving specimen grinding and gamma spectroscopy. These data were used to predict corrosion behavior under Molten Salt Reactor operating conditions. (auth)

8160 (ORNL–4370, pp 16-20) ELECTRON MICROSCOPY. Stiegler, J. O. (Oak Ridge National Lab., Tenn.).

Thermal and stress-assisted growth processes of grain-boundary gas bubbles in chemical vapor deposited W are described and analyzed by existing models. Steps in the thermal rejection and precipitation of gas bubbles in electrodeposited Ni are outlined and explained in terms of gas-bubble nucleation and growth in a material supersaturated with vacancies. The annealing characteristics of voids in irradiated stainless steel are presented, and a model in which void shrinkage is controlled by diffusion of vacancies from voids to dislocations is developed. The energy stored during deformation of Ag single crystals is reported and related to work-hardening theories and dislocation structures. Complex precipitation reactions in Hastelloy N resulting from various thermomechanical treatments are described. Techniques for the observation of bubbles and cavities in solids are summarized. Electron microscope-microprobe techniques for studying precipitate particles in metals are described, and a procedure for the preparation of transmission electron microscopy specimens from tubing is outlined. (auth)

8161 (ORNL–4370, pp 21-5) ELECTRONIC PROPERTIES OF METALS AND ALLOYS. Betterton, J. O. Jr. (Oak Ridge National Lab., Tenn.).

Moessbauer measurements with ^{61}Ni in the Cu–Ni system showed nearly linear isomer shifts of ^{61}Ni with atomic fraction Ni and indications of localization of electronic states, since after corrections for Doppler shifts the ^{61}Ni in the alloy has the same isomer shift as in pure Ni. Investigations of ordered Fe–Al alloys by neutron capture in ^{56}Fe at Karlsruhe revealed interesting information on displacements of Fe nuclei during neutron irradiation. The atomic heat of UN from 1.3 to 4.6°K obeyed $\gamma T + \beta\,(T/324)^3$ where γ was about 24 mJ(g-atom)$^{-1}$ deg^{-2} varying with heat treatment; the magnitude of γ reflects 5f bands intersecting the Fermi surface. Zone purification of Hf in ultrahigh vacuum successfully removed impurities other than Zr. Low-temperature electrical resistivity of Zr alloys dilute in Sc, Ti, or Hf and specific heats of alloys dilute in Nb, Mo, Re, Ru, Rh, or Pd were measured and associated with the electronic structures of the atoms involved. (auth)

8162 (ORNL–4370, pp 35-8) PHYSICAL PROPERTIES. McElroy, D. L. (Oak Ridge National Lab., Tenn.).

Theoretically based analyses of accurate physical property data available on a few metals and alloys allowed a separation of their electronic and lattice components of thermal conductivity. This provided several interesting theoretical consequences and guidelines for data extrapolation and for further research. Physical property studies on Cu, In, Mo, and Cr showed that available theory can only qualitatively explain thermal conductivity results. It was found that the thermal resistivity of ThO_2 is controlled by Umklapp scattering, whereas that of UO_2 is largely controlled by spin-wave scattering of phonons. It was found that the thermal conductivity of UO_2 was unaffected by large temperature gradients or compressive stresses. New apparatus for measuring more accurately physical properties over a broad temperature range are briefly described. (auth)

8163 (ORNL–4370, pp 52-4) THEORETICAL RESEARCH. Borie, Bernard (Oak Ridge National Lab., Tenn.).

Routine x-ray diffraction analyses are summarized. Crystal structures of $La_2Be_2O_5$ and $SrBe_2O_4$ were determined. Only tetrahedral coordination of oxygen about Be was found in the former, but a mixture of trigonal and tetrahedral coordinations in the latter. An analytic separation of first- and second-order thermal diffusion scattering was derived. Experimental improvements in the measurement of small-angle x-ray scattering were made so that the sample temperature could be controlled between –170 and 450°C. Provision for automatic control of balanced filters was designed. Small-angle x-ray scattering measurements from Al–Zn alloys were begun; results indicate compositional inhomogeneities at all temperatures studied in the single-phase alpha field. Further experiments with highly-oriented graphite continue to show the advantages of this material as an x-ray monochromator both in diffraction experiments and in fluorescence applications. (auth)

8164 (ORNL–4370, pp 59-67) PHYSICAL AND MECHANICAL METALLURGY OF HIGH-TEMPERATURE MATERIALS. Harms, W. O. (Oak Ridge National Lab., Tenn.).

The creep-rupture properties of wrought C-129Y were found to be among the lowest for Nb-base alloys in the range 980 to 1200°C. Recrystallized and aged SU-16 alloy exhibited the highest strength for Nb-base alloys in this temperature range. Optimized heat treatment of the Mo alloy TZC did not give creep-rupture properties as good as those of Nb modified TZM (Cb-TZM). In studies on time-temperature parameters for representation and extrapolation of creep-rupture data for refractory alloys, the Manson-Haferd parameter was superior to those of Dorn-Shepard and Larson-Miller. The elevated-temperature fatigue life of D-43 at the 1% plastic strain level was equal to or superior to that at room temperature, whereas in liquid N it was one-fifth of the room temperature value. The solubility and diffusivity of N in W at 1800°K and 1 atm pressure were determined to be 28 ppM and 2.6×10^{-8} cm^2/sec, respectively. Studies on strengthening of refractory alloys by controlled spinodal decompositions showed that Guinier-Preston zones in Nb–Hf and TaHf alloys containing 40 to 65% Hf and quenched from 1730 to 1850°C grew rapidly on aging because of the existence of vacancy clusters. In 1000-hr creep tests on Haynes alloy No. 25 in high vacuum at 785°C, evaporation losses and amount of Laves-phase precipitate increased with stress. At a stress of 14,500 psi the rupture life in a vacuum of 1×10^{-8} torr was about one-tenth that of specimens tested in air. The alloy Ti–21% V–25% Cr was outstanding for brazing Al_2O_3 and refractory metals as well as graphite to itself and to refractory metals. Brazing alloys of Ti–Zr–Ta and Ti–Zr–Nb were shown to be applicable for a variety of combinations of refractory materials, and the Ti–20% Zr–15% Ge alloy exhibited excellent wetting and flow characteristics on graphite for low temperature brazing. The electrical resistivity and thermoelectric power of high-purity Mo were measured from 100 to 1700°K and the thermal conductivity was determined from 100 to 1250°K. Improved techniques were developed for nondestructive testing of small tubing and rods of refractory alloys by fluorescent-penetrant, ultrasonic, and eddy-current techniques. (auth)

8165 (ORNL–4370, pp 120-4) MECHANICAL PROPERTIES RESEARCH. Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.).

The radiation resistance after cyclotron and reactor irradiation of both the Ti-modified types 304 and 304L stainless steels under high-temperature creep conditions was found to be superior to that of the standard compositions. Modified 304L stainless steel was fabricated successfully into LMFBR-size tubing, and end cap welds appeared sound. Type 316 stainless steel and Incoloy 800 both exhibited a maximum in postirradiation ductility as the Ti content was increased. In 50-lb vacuum-induction melts of the stainless steel the maximum in ductility occurred in the range of 0.1 to 0.3% Ti and about 0.1% Ti in Incoloy 800. The high-temperature creep-rupture properties of Hastelloy N were significantly influenced by the amounts of Ti and C in the alloy. Both strength and ductility increased with Ti and C additions. The behavior is contrasted with the appearance of a maximum in the ductility as a function of Ti concentration observed in the other alloys studied. Nuclear heating rate experiments in EBR-II were completed, and irradiation experiments have been designed, constructed, and installed in EBR-II. Type 304L stainless steel from a driver fuel pin in EBR-II was examined and found to contain voids attributable to displacement damage at 370 to 470°C. The voids began to anneal (disappear) at 600°C and were entirely removed by annealing 1 hr at 900°C. (auth)

8166 (ORNL–4370, pp 125-32) NONDESTRUCTIVE TEST DEVELOPMENT. McClung, R. W. (Oak Ridge National Lab., Tenn.).

Development of analytical techniques for calculation of parameters for an induced electromagnetic field, with emphasis on closed-form solutions, continued. Numerical values are being obtained on a time-sharing computer for many problems of interest to eddy-current testing. Improvements were made on portable phase-sensitive eddy-current instruments. The effective diameter of eddy-current fields was measured and methods for decreasing the size were studied. To minimize thermal drift, materials with low-temperature coefficients are being investigated for fabrication of eddy-current coils. Fabrication and measurement studies on notch reference standards for ultrasonic inspection continue. The schlieren system for viewing ultrasonic energy was modified to increase both viewing area and sensitivity; parabolic mirrors were substituted for collimating lenses and closed circuit television was used for display of images. An ul-

trasonic frequency analysis system was developed to allow investigation of the significance of frequency in ultrasonic tests. Parameters for the generation of holograms, using both single- and multiple-beam techniques, were studied. An electronic circuit was developed to allow real-time averaging of quantitative x-ray attenuation data during scanning of specimens. (auth)

8167 (ORNL–4370, pp 151-5) JOINING RESEARCH ON NUCLEAR MATERIALS. Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

The effects of Al, Ti, P, and S, individually and collectively, on the weldability of Incoloy 800 were studied. Both the VARESTRAINT Test and Duffer's Gleeble were employed. Al and Ti additions to the ternary (Fe-Ni-Cr) Incoloy 800 composition increased the alloy's susceptibility, as measured by the VARESTRAINT Test, to weld-metal hot cracking; however the degree of cracking was considerably less than that exhibited by commercial Incoloy 800 plate. Similar results were also obtained with the Gleeble heat-affected zone tests. The presence of Al and Ti decreased the Zero Ductility Temperature (ZDT) from approximately 2450°F for the ternary to about 2400°F. P and S did not decrease the ZDT below the 2400°F level. This apparent innocuous effect of P and S may be due to association with Ti and/or Al. (auth)

8168 (ORNL–4370, pp 175-8) HEAVY SECTION STEEL TECHNOLOGY. Canonico, D. A. (Oak Ridge National Lab., Tenn.).

As part of an engineering program to develop the technology of fracture mechanics to the point where it is capable of defining the safe behavior of a nuclear pressure vessel an investigation was conducted on the effect of flame cutting on thick-section steel plates. Material studied was ASTM A533, Grade B, Clad I-plates which were rolled to 12-in. thickness and subsequently flame cut to 20 × 10 ft. After cutting, the plates were normalized, austenitized, quenched, tempered, and stress-relieved for 40 hr at 1150°F. It was found that the depth of the heat-affected zone (HAZ) at the plate surfaces approached $^{3}/_{4}$ to 1 in. This depth dropped rapidly to between $^{3}/_{16}$ and $^{1}/_{4}$ in. The microstructure was typical of a weld heat-affected zone, containing a grain-coarsened region adjacent to the fusion line, which blended gradually into a fine-grained zone, which in turn blended into the unaffected base metal. Results show that the depth of HAZ is minimal (maximum about $^{1}/_{4}$ in. if surface effects are ignored). It need not be considered in normal specimen or weld-joint preparations since conventional machining processes will remove more than this amount. Microstructures appeared to be wholly bainitic. (auth)

8169 (ORNL–4370, pp 219-20) TERRESTRIAL LOW-POWER REACTOR. Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

It appears that Ti may be the preferred structural metal for a pressurized water reactor, due to its resistance to corrosion, and the fact that complicated water-treatment systems with accompanying instrumentation, controls, plumbing, and other equipment may be eliminated by its use. Uranium dioxide pellets in a metal tube should satisfactorily meet the requirements of a 50-MWyr core life at a peak linear heat rating of 5.9 kW/ft. (auth)

8170 (ORNL–4370, pp 235-7) ROVER ROCKET MATERIALS. Clausing, R. E. (Oak Ridge National Lab., Tenn.).

Multiple-tube bundles of Hastelloy X and type 347 stainless steel, which simulated rocket nozzle configurations, were tested in thermal fatigue, and the results were correlated with the test parameters and the low-cycle fatigue properties of the alloys. Thermal cycles typical of nozzle service conditions produced intergranular failures in 23 to 87 cycles in both materials. Studies on the effects of gaseous contamination on the adhesion of rocket engine materials have been expanded. Adhesion is harder to produce with engineering materials than with pure metals under only static normal-force loading. Surface shearing produces adhesion in some of the engineering materials. Oxygen inhibited adhesion more than hydrogen for materials that exhibit significant adhesion in ultrahigh vacuum. Preliminary studies indicate that outgassing of the reactor fuel elements will determine the gaseous environment for the engine components. Since this outgassing cannot be estimated from existing data, a study has been started to determine the quantity, species, and rate of outgassing under simulated space conditions. (auth)

8171 (UCRL–70524) ELEVATED TEMPERATURE DEFORMATION AND ELECTRON MICROSCOPE STUDIES OF POLYCRYSTALLINE TUNGSTEN AND TUNGSTEN–RHENIUM ALLOYS. Barmore, Willis L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1, 1968. Contract W-7405-eng-48. 62p. (CONF-680603-3). Dep. CFSTI.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte, Tirol, Austria.

Tungsten, tungsten-25 wt % rhenium and tungsten-30 wt % rhenium were plastically deformed from 1400 to 1900°C at stresses up to 10,000 psi in a vacuum of less than 10^{-8} torr. The activation energy for creep and the relationship between stress and strain rate were determined. Effects of thermomechanical history, composition, and grain size on strain rate were also investigated. Dislocation substructure was studied by etch pit and transmission electron microscope techniques, and these observations were correlated with the creep data. The factors important in the high-temperature deformation of these materials were analyzed, and the experimental results were rationalized in terms of current theories for rate-controlling deformation mechanisms. (auth)

8172 WELDING OF FUEL ELEMENT CANS OF AUSTENITIC STAINLESS STEEL. Aerts, L. (BelgoNucleaire, Brussels); Van Asbroeck, Ph.; Schrijvers, J.; De Boeck, P.; Bairiot, H. Rev. Soudure, 24: No. 1, 12p.(1968). (In French). (NP–17677).

Fabrication of plutonium-enriched ceramic austenitic stainless steel clad fuel elements demands two welding operations. Claddings welded by the TIG argon-arc procedure, the outer diameter of the element being between 8.5 and 16 mm and the thickness being 0.5 mm are studied. The characteristics of a welding and the parameters occurring during the operation of welding are noted, the correlations between these factors are examined, a mode of operation, and the control methods of quality are described. (tr-auth)

8173 PLASTIC DEFORMATION OF HIGH-PURITY BERYLLIUM MONOCRYSTALS AT 4.2 TO 300°K. Gindin, I. A.; Grinyuk, V. N.; Ivanov, V. A.; Lazareva, M. B.; Papirov, I. I.; Starodubov, Ya. D.; Tikhinskii, G. F.; Finkel, V. A. (Inst. of Physics and Technology, Moscow). Fiz. Metal. Metalloved., 26: 157-63 (July 1968). (In Russian).

The temperature dependence of critical intensities of beryllium basic shear stress (τ_{0001}) under pressure at 4.2 to 300°K and plastic deformation of high-purity beryllium were investigated. Characteristics of the basic shift, strengthening, thickness of the slip layers, and the shift along the pyramid plane were analyzed. (tr-auth)

8174 EFFECTS OF GAS IMPURITIES ON THE FRIABILITY TEMPERATURE THRESHOLD OF HIGH-MELTING METALS. Shashkov, D. P. (Inst. of Steel and Alloys, Moscow). Fiz. Metal. Metalloved., 26: 110-14(July 1968). (In Russian).

Local gas analysis of high-melting metals (99.85% Cr, 99.9% Mo, and 99.8% W) showed that segregation of gas impurities between the grain boundaries is one of the causes inducing friability in the studied specimens. The transition from the brittle state into plastic is usually accompanied by resorption of gas impurities along the grain boundaries. (tr-auth)

8175 URANIUM DIFFUSION IN TITANIUM–MOLYBDENUM ALLOYS. Pavlinov, L. V. At. Energ. (USSR), 25: 434-5(Nov. 1968). (In Russian).

Uranium diffusion in binary titanium–molybdenum alloys was studied in alloys with 5 to 30 at. % Mo. Molybdenum effectively stabilized the bcc-lattice of titanium. Molybdenum also reduced the temperature of polymorphic $\alpha \rightleftharpoons \beta$ transformation (from 882°C for pure Ti to 650°C for alloys with 15 at. % Mo) and increased the temperature of Ti melting point. Uranium diffusion coefficient was determined by integral residue method using α-radiation of ^{235}U at 900, 1000, 1100, 1250, and 1400°C. Graphs are given on temperature dependence of uranium diffusion in Ti–Mo alloys. Data on energy activation and frequency factor for U diffusion in Ti–Mo and pure Ti are tabulated. (R.V.J.)

8176 MECHANICAL PROPERTIES OF A-302B PLATE FOR NUCLEAR REACTORS. Gondo, Hisashi; Sato, Makoto (Yawata Iron and Steel Co., Ltd., Japan). Seitetsu Kenkyu, No. 258, 7343-50(Mar. 1967).

Experiments were conducted to determine the effects of heat treatments on the mechanical properties and weldability, of A-302B steel and Ni-added steel thereof (mainly with 100 and 155 mm plates). For the most part, changes in the mechanical properties of materials tempered at 625°C which were dependent on the frequency of stress-relieving annealing were investigated, and it was found that material deterioration produced by the stress-relieving annealing can be explained in terms of the spheroidizing and growth of complex carbides. (NSA of Japan)

8177 TEMPERING CHARACTERISTICS OF ASTM-A-302B STEEL FOR ATOMIC PILE USE. Nagashima, Shinichi; Mori, Naomichi (Yawata Iron and Steel Co., Ltd., Japan). Seitetsu Kenkyu, No. 258, 7331-42(Mar. 1967).

The temporary characteristics of quenched and normalized ASTM-A-302B steel were studied with respect to their mechanical

properties, structures, and composition and kind of carbide. Under tempering conditions at 650°C for 1 hr, both samples showed the best impact property, but it was found that quenched-tempered steel was superior to normalized tempered steel in impact and tensile properties except elongation. These findings can probably be related to characteristics of the microstructure, particularly the difference in sub-grain dimensions and precipitate distribution, shape, and size. (NSA of Japan)

8178 HELIUM EMBRITTLEMENT OF INCOLOY 800. Garr, K. R.; Kramer, D.; Rhodes, C. G.; Pard, A. G. (Atomics International, Canoga Park, Calif. North American Rockwell Science Center, Thousand Oaks, Calif.). J. Nucl. Mater., 28: 230-2(Nov. 1968).

Irradiated tensile samples of Incoloy 800 were tested in vacuum. The helium concentration was determined by mass spectrometry. Data indicated that helium has no effect on the yield and tensile strengths at the testing temperature of 500 to 800°C. Total elongation showed a marked decrease at 600°C and above. Extensive void formation along grain boundaries existed. Samples revealed bubbles at all test temperatures. Comparisons were made with Types 304 and 316 stainless steels previously studied. (J.C.W.)

8179 BUBBLE TRAILS IN OXIDE FUELS. Rosenbaum, H. S. (General Electric Co., Pleasanton, Calif.). J. Nucl. Mater., 28: 225-7(Nov. 1968).

A 6.35 mm diameter pin of 20 wt % PuO_2–80 wt % UO_2 pellet fuel was sintered to 94% theoretical density. The pin was filled with helium and irradiated 4.2 hr to an average burnup of 50 MWd/t. Bubbles trails are observed in a cross section after etching in acid. Trails have been observed in irradiated and unirradiated fuels exposed to severe temperature gradients. An explanation of the bubble trails is given and the excess solubility near a bubble is mathematically estimated. A listing of 8 references is given. (J.C.W.)

8180 ON THE ANISOTROPY IN MECHANICAL PROPERTIES OF EXTRUDED COMMERCIAL SAP MATERIALS. Nilsson, T. M. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 28: 220-4(Nov. 1968).

Bars of SAP with a diameter of 61 mm were manufactured from ball-milled Al powder by cold compaction, vacuum annealing at 600°C, hot compaction, and hot extrusion. Tensile specimens were machined from the bar. Tensile testing at 450°C showed that the material is strongest when tested in the longitudinal direction. Ductility measured as total elongation is greatest for 0 and 60° orientation. It is concluded that mechanical properties by tensile testing of an extruded bar of SAP 895 at room temperature and 450°C are dependent on the direction of testing relative to the extrusion direction. Properties are low for transverse directions and for orientations between longitudinal and transverse directions. The responsible factor for the anisotropy appears to be the uneven distribution of oxide particles formed during extrusion. (J.C.W.)

8181 DIFFUSION AND SOLUBILITY OF PLUTONIUM IN NICKEL. Blechet, J. J.; van Craeynest, A.; Calais, D. (CEN-FAR, Fontenay-aux-Roses, France). J. Nucl. Mater., 28: 177-84(Nov. 1968). (In French).

The diffusion coefficients at infinite dilution, and the solubility of plutonium and nickel were determined by α autoradiography. The technique of welded couples was used in conjunction with a polyphase system (Ni saturated with Pu + precipitates of Pu_2Ni_{17} attached to pure nickel). The diffusion coefficients were determined from examination of the precipitates existing in contact with the interface after annealing, using Fick's equation for a semi-infinite medium with constant surface concentration. For a sufficiently large proportion of precipitates one can take it that throughout the anneal the interface remains at fixed concentration, which is the solubility limit; this is obtained by extrapolating the concentration/penetration curve. The activation energy, 51 ± 5 kcal/mole, is slightly lower than that for the self-diffusion of nickel, 65 ± 5 kcal/mole (the atomic radius of plutonium, 1.69 to 1.82 Å according to allotropic form is larger than that of nickel, 1.38 Å). The frequency factor is in the range 0.14 to 1.14 cm^2/sec. Between 1025 and 1125°C, the solubility of plutonium in nickel is in the range 130 to 320 × 10^{-4} wt %. (tr-auth)

8182 HIGH TEMPERATURE SOLUBILITY OF NITROGEN IN TUNGSTEN. Fromm, E.; Jehn, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals, 17: 124-6 (Jan. 1969). (In German).

The pressure and temperature dependence of the solubility of nitrogen in tungsten was investigated. The heat of solution was found to be 93.4 kcal/mole N_2. (M.C.G.)

8183 INFLUENCE OF SILICIDE COATINGS ON MOLYBDENUM ON ITS MECHANICAL PROPERTIES. Ivanov, V. E.; Nechiporenko, E. P.; Zmii, V. I.; Azhazha, V. M.; Polyakov, N. I.; Osipov, A. D. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1685-8(Oct. 1968). (In Russian).

Reduction of the rate of deformation from 300 to 0.3% per hour did not change the influence of silicides on the mechanical properties of molybdenum. With the lower rate of deformation the largest zone of embrittlement shifted toward lower temperatures. At temperatures above 1000°C molybdenum with a silicide coating was more plastic and had an increased resistance to creep. (tr-auth)

8184 ZENER DIFFUSION PARAMETER IN THE RARE EARTH METALS. Rosen, M.; Dariel, M. (Nuclear Research Centre, Beer Sheba, Israel). J. Less-Common Metals, 17: 119-20(Jan. 1969).

The Zener diffusion parameter is defined by: $\beta = -d(\mu/\mu_0)/d(T/T_m)$, where μ and μ_0 are the shear moduli at a temperature T and at T = 0, respectively, and T_m is the melting point of the metal. The variation of the Zener diffusion parameter as a function of atomic number in the rare earth metals series is shown. (M.C.G.)

8185 MIXED-CRYSTAL HARDENING OF NIOBIUM. Kostorz, Gernot (Univ., Goettingen, Ger.). Z. Metallk., 59: 941-52(Dec. 1968). (In German).

The theoretical and experimental basis of an investigation of solid-solution hardening of bcc metals is analyzed. The plateau hardening is studied in terms of atomic size misfit δ and modulus defect η for single crystals of niobium alloyed with Ta, V, W. Good agreement is found between experimental results and Fleischer's theory of elastic interaction with screw dislocations, leading to a hardening parameter $|\eta' - 16\delta|$. While for Nb–Ta, –V the theoretical concentration dependence is obeyed, for Nb–W indications of additional SRO hardening are found. (auth)

8186 ANISOTROPY IN THE ENERGY SPECTRUM GAP OF SUPERCONDUCTORS. Shepelev, A. G. (Physico-Technical Inst., Kiev). Usp. Fiz. Nauk, 96: 217-59(Oct. 1968). (In Russian).

The microscopic theory explains the superconductivity of metals by the appearance of a region of forbidden electron states in the energy spectrum near the Fermi surface, generating electron pairs with opposite pulses and signs in the superconductor. The energy gap may be calculated from experimental measurements of various physical properties. Deviations from the predictions of the theory based on isotropy of the phenomenon are due to the anisotropy of the energy gap. The experimental measurements included determination of electron heat capacity, critical magnetic field, electron thermal conductivity, absorption in the ultrasonic and infrared regions, magnetic field penetration, surface impedance, and tunnel effect. It is concluded that the temperature-dependent energy gap is responsible for many of the properties of the superconductors. The superconductivity theory based on the idealized model of the metal with an isotropic, single-bond Fermi surface and an isotropic gap is able to account for most of the properties. Recent experimental results revealed that the energy gap of superconducting Al, V, Ga, In, Cd, La, Mo, Nb, Sn, Pb, Ta, and Zn is anisotropic; this is related to the anisotropy of the Fermi surface of metals and of their phonon spectrum. (247 references). (TTT)

8187 EFFECT OF THE CONDITIONS IN HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT ON THE PROPERTIES OF MAGNESIUM–NEODYMIUM ALLOYS. Drits, M. E.; Oreshkina, A. A.; Sviderskaya, Z. A. Fiz. Khim. Obrab. Mater., No. 1, 112-14(1968). (In Russian).

The effect of the degree of deformation in high-temperature thermomechanical treatment on the mechanical properties and structure of magnesium–neodymium alloys has been investigated. Two alloys containing 3.1 and 2.6% neodymium were melted from 99.91% pure neodymium and magnesium–neodymium (21.7% Nd) master alloy. Obtained ingots were annealed for 2 hr at 535°C, air cooled to 300°C, and extruded into rods 10.5, 14.5, and 19.5 mm in diameter with 87, 73, and 54% reduction, respectively. So-treated specimens were tensile tested at 20, 250, and 300°C. It is concluded that optimum reduction in high-temperature thermomechanical treatment of magnesium–neodymium alloys depends significantly on the neodymium content. The optimal combination of strength and ductility characteristics in the alloy containing 2.6% neodymium was obtained after 73% reduction, while that in the alloy containing 3.1% neodymium was obtained after 87% reduction. (ATD)

8188 ON THE CREEP-RUPTURE STRENGTH OF MOLYBDENUM COMPOSITE CAST WITH SOME HEAT-RESISTANT ALLOYS. Yoda, Renpei; Arai, Takashi (National Research

Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 32: 836-41(1968). (In Japanese).

Molybdenum, coated with nickel-base, iron-base, and cobalt-base heat-resistant alloys by casting, was hot-worked for its high temperature uses under the stressed condition in air, and the results of the creep-rupture test were compared. When S-816 cobalt-base heat-resistant alloy was used as coating materials, the bonding by fusion between molybdenum and S-816 is considerably inferior to the others. It was known that one of the reasons is that the coefficient of melting rates of molybdenum into molten S-816 alloy is especially small. Molybdenum coated with any of the heat-resistant alloys can be best swaged at 1150°C, and cracking on the molybdenum part and the diffusion zone rarely occurred. In the creep-rupture strength at 1000°C in air, molybdenum coated with S-816 was strongest for the large stress and short time, while molybdenum coated with Nimonic 90 nickel-base alloy was strongest for the small stress and long time. (auth)

8189 THE EFFECT OF PRECIPITATION ON THE CRITICAL CURRENT DENSITY OF Nb–40 AT. PERCENT Zr–10 AT. PERCENT Ti ALLOY IN MAGNETIC FIELD. Doi, Toshio; Ishida, Fumihiko; Kawabe, Ushio; Kitada, Masahiro (Hitachi Ltd., Kokubunji, Japan). Nippon Kinzoku Gakkaishi, 32: 886-92(1968). (In Japanese).

The superconducting properties were examined on Nb–Zr–Ti alloys with an extensive range of composition, and the effect of precipitation on the critical current density Jc of Nb–40 at. % Zr–10 at. % Ti alloy in magnetic field was investigated in relation with the microstructural changes due to the transformation of the β to the β' and β'' phases at 700°C. The composition range with high values of Jc was found to expand over the line binding the compositions Nb–47 Zr and Nb–67 Ti in Nb–Zr–Ti alloys. Nb–40 Zr–10 Ti alloy has the highest Jc below 80 kOe. For Nb–40 Zr–10 Ti alloy aged intermediately at 700°C for 3 hr, the critical field was 105 kOe at 4.2°K; the value of Jc was 3.6×10^5 A/cm^2 at 40 kOe and 5.0×10^4 A/cm^2 at 80 kOe; and the critical temperature was 10.3°K. It may be due to the flux-pinning of the β' phase, the weaker superconductor in the β' and β'' phases, that the Jc value of Nb–40 Zr–10 Ti alloy increases by aging at 700°C. The Jc value reaches a maximum value as the size of the β' phase and the spacing between them approach the order of 10 to 10^2 Å. (auth)

8190 THE EFFECT OF PRECIPITATION ON THE CRITICAL CURRENT DENSITY OF Nb–5 AT. PERCENT Zr–60 AT. PERCENT Ti ALLOY IN MAGNETIC FIELD. Ishida, Fumihiko; Doi, Toshio; Umezawa, Tadashi (Hitachi Ltd., Kokubunji, Japan). Nippon Kinzoku Gakkaishi, 32: 893-7(1968). (In Japanese).

The critical current density Jc vs applied magnetic field H characteristics were examined on the Nb-Ti side alloys in the Nb-Zr-Ti system, and the effect of precipitation on the Jc vs H characteristics was investigated in relation to the microstructural changes due to the transformation of the β to the α and β phases at 400 to 600°C in Nb–5 at. % Zr–60 at. % Ti alloy. The composition with the high Jc at 70 to 90 kOe was the Nb–5 Zr–60 Ti alloy. For the Nb–5 Zr–60 Ti alloy aged at 400°C for 100 hr, the value of Jc was 6.4×10^4 A/cm^2 at 70 kOe and 4.4×10^4 A/cm^2 at 80 kOe. It may be due to the flux-pinning of the α phase, the normal conductor at 4.2°K in the α and β phases, that the Jc value of Nb–5 Zr–60 Ti alloy increases by aging at 500°C. Flux-pinning by α precipitates was most effective in the early stages of precipitation and the growth of precipitates resulted in reduced values of Jc. The peak effect of Jc may be due to the interaction between flux lines at high magnetic field near critical field H_{C_2} in the structure with random distribution of pinning strength. (auth)

8191 ELECTRON-OPTICAL STUDIES OF W–Mo ALLOYS. Pumpurs, V. M.; Spivak, G. V.; Shishkik, B. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1035-8(June 1968). (In Russian).

The local emission current of a part of the surface having a diameter of ~1.0 μm was measured on thin W–Mo samples. A Pt–Pt Rh thermocouple was welded to the center of the metal strip with the emf being determined potentiometrically. The sample was mounted on a stainless steel frame and served as the cathode of an immersion objective. The cathode was boiled in weak caustic and rinsed with alcohol before installation in the microscope. The local emission current struck a Faraday cylinder and was measured with an amplifier. All experiments were carried out at a cathode temperature of 1650 to 1850°K. Samples of W and Ta showed a local work function of 4.6 V for W and 4.1 V for Ta. The work function distribution was found to vary at 1600°C due to a growth in grain size and degassing at high temperature. Thus it is possible to carry out measurements of the local work function of refractory metals in the electron-emission microscope. (TTT)

8192 EP404 AND EP454 ECONOMICAL HEAT-RESISTANT ALLOYS. Khatalakh, R. F.; Krasnova, I. A.; Dubrovina, I. N.; Zimina, L. N.; Kosheleva, G. F. pp 205-8 of Svoystva i Primenenlye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Two new EP404 and EP454 nickel-iron base wrought heat-resistant alloys were developed as less expensive substitutes for ET867 and EI827 nickel-base alloys intended for short-time operation under high stresses. The new alloys are available in the form of forgings and rolled stock. Both can be hot worked in the 950 to 1200°C range compared with the 1050 to 1150°C range for EI827 and EI867 alloys. The heat treatment of EP404 and EP454 alloys includes annealing for 6 hr at 1175 to 1200 and 1150 to 1175°C, respectively, followed by air cooling and aging at 750 to 800°C for 10 hr. The heat-treated alloys have high strength and ductility in the 20 to 800°C range comparable to those of EI827 and EI867 alloys. EP404 alloy has a high yield strength (80 kg/mm^2) at 20 to 800°C and EP454 alloy has an impact strength of about 12 to 19 kg·m/cm^2 in the 930 to 1200°C range. Both alloys soften at temperatures above 800°C. The rupture strength of EP404 and EP454 alloys at 750°C was practically the same as that of EI867 and EI827 alloys. The 100-hr rupture strength of EP454 alloy at 850°C was 20 kg/mm^2 and the 200-hr rupture strength at 800°C was 25 kg/mm^2. EP404 alloy has higher characteristics of heat resistance [unspecified] than EP454 alloy. Prolonged aging of EP404 alloy at 800°C resulted in the precipitation of the brittle ϵ-phase (an Fe_7W_6-type phase containing about, wt %, 14 Ni, 10 Cr, 11 Fe, 37 Mo, 28 W). This can be avoided by annealing at 1000°C and subsequent aging. Stressless aging of EP404 alloy at 750°C brought about no changes in the structure or hardness. Aging under a stress of 50 kg/mm^2 for 0.5 to 10 hr caused intensive precipitation of the γ'-phase (Ni_3Al) with no ϵ-phase precipitation. Aging of EP454 alloy at 750 and 800°C with or without stress changed the alloy hardness very little. No structural change was observed in EP404 and EP454 alloys with aging at 750°C for 100 hr, indicating the structure stability of the alloys. (ATD)

8193 PHYSICOCHEMICAL INVESTIGATION OF ALLOYS OF THE NIOBIUM–TUNGSTEN–MOLYBDENUM–CHROMIUM SYSTEM. Prokof'ev, D. I.; Grum-Grzhimaylo, I. V. pp 128-31 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A series of niobium-base quaternary alloys containing Nb, Mo, W, and Cr were melted from 99.6 to 99.96%-pure materials in a nonconsumable electrode arc furnace in an inert atmosphere. Cast alloys were homogenized and then annealed at 1000°C. All annealed alloys had an alpha-solid solution structure which remained unchanged with prolonged high-temperature annealing. Physicochemical investigation revealed the existence of a niobium-base quaternary solid solution. Complex alloying with Mo, W and Cr significantly strengthened niobium by the formation of solid solutions of a simple or complex composition. Hardness at room and elevated temperatures increased appreciably with increasing content of the alloying elements. Hot hardness measurements showed no significant decrease in the heat resistance of the alloys at temperatures up to 1100°C. The oxidation resistance of the alloys at 1000°C revealed the existence of a region of alloys with higher oxidation resistance than that of the existing niobium alloys. In the best alloys with the lowest oxidation rate, the depth of oxygen penetration was 0.2 to 0.3 mm after a 50 hr exposure at 1000°C, compared with several millimeters for pure niobium. (ATD)

8194 TEST FOR EVALUATING THE SUSCEPTIBILITY OF NIOBIUM–ALLOY WELDS TO HOT CRACKING. Klebanov, G. N.; Chernysheva, T. A. pp 135-9 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A new testing method for evaluating the susceptibility of niobium-alloy welds to hot cracking was proposed. The test specimens are made of niobium-alloy sheets 1 mm thick and 50 or 80 mm wide with a narrow slit cut in them. A weld bead is deposited on the specimen in such a way that the center line of the weld goes through the end of the slit. The rate of deformation is determined by measuring the speed at which the slit opens. The deformation rate increases with increasing length of the weld between the starting point and the slit and with increasing welding speed. The criterion of weld resistance to hot cracking is the maximum length of the weld at which cracking does not occur. The test has been successfully applied to a series of niobium alloys. (ATD)

8195 STRENGTH AND DUCTILITY OF SOME SINGLE-PHASE AND TWO-PHASE ELECTRON BEAM-MELTED NIOBIUM-BASE ALLOYS. Movchan, B. A.; Malashenko, I. S. pp 99-104 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The microstructure and mechanical properties have been investigated in electron beam-melted binary Nb–0.1% C and Nb–0.15% C alloys, in ternary Nb–16.5% W–0.1% C and Nb–16.5% W–0.15% C alloys, and in a quaternary Nb–16.5% W–0.1% C–0.5% Zr

alloy. Carbon in an amount of 0.15% increased the susceptibility to brittle failure of niobium and Nb–W solid solution at room temperature. Generally, the addition of more than 0.1% C led to a complete loss of ductility of all tested alloys. At temperatures higher than 0.45 of the melting temperature, the addition of 0.1% carbon effectively strengthened the alloy matrix. Alloying Nb–16.5% W–0.1% C alloy with 0.5% Zr increased the strength and ductility characteristics of cast metal, e.g., the tensile strength from 51.3 to 59 kg/mm^2 and elongation from 4.8 to 10%. Zirconium addition also reduced the anisotropy of the mechanical properties of cast Nb–W–C alloys. After hot deformation and annealing Nb–C alloys at 1150°C for 2 hr and Nb–W–C alloys at 1400°C for 2 hr, the alloys had a recrystallized structure with a respective grain size of 5 to 6 and 7 to 8 (on the standard scale) and with uniformly distributed globular carbide particles. Recrystallized Nb–16.5% W–0.1% C–0.5% Zr alloy had a room-temperature tensile strength of 70 kg/mm^2, an elongation of 27.8%, a reduction of area of 55.6% and a tensile strength of 35.0 kg/mm^2 at 1200°C. Complex alloying of niobium with elements of the IVa and VIa groups wihin the limits of solid solutions makes it possible to obtain high-strength compositions with a satisfactory ductility at room temperature. (ATD)

8196 TEMPERATURE DEPENDENCE OF THE MECHANICAL PROPERTIES OF MOLYBDENUM, NIOBIUM, AND NICKEL. Klypin, B. A. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 39, 162-9(1965). (In Russian).

A unit and a method have been developed for rapid tension testing of metals at −196 to 2800°C. An electromagnet with a pulling force of up to 15,000N can develop a required maximum tensile stress in 0.05 to 0.3 sec, which ensures a sufficiently constant test temperature. Forged and subsequently annealed specimens of vacuum-arc melted 99.09%-pure molybdenum, 99.54%-pure niobium, and 99.58%-pure nickel were heated to a required temperature at a rate of 30 to 50°C/sec in an argon atmosphere and subjected to tension tests. The test results confirmed the previously known difference in the nature of the temperature dependence of the mechanical properties of metals with bcc and fcc lattices. Results of the investigation of the dependence of mechanical properties on homologous temperature showed three temperature ranges for metals with a bcc lattice (Mo and Nb) as follows: The range below 0.15 to 0.2 T_{mel} in which the tensile and yield strengths sharply increase with decreasing temperature and a simultaneous sharp decrease in the reduction in area (ψ); the 0.2 to 0.5 T_{mel} range in which the mechanical properties of Mo and Nb change only slightly; and at temperatures higher than 0.5 T_{mel} in which the strengthening of metal with deformation occurs simultaneously with recrystallization. At this temperature the strength decreases more intensively with increasing temperature. All the investigated metals were found to be susceptible to intergranular cracking in the 0.5 to 0.75 T_{mel} range. The development of the cracks and the nature of the failure depend on the metal purity, the kind and distribution of impurities, and the rate of deformation. The values of the mechanical properties obtained with the new unit at temperatures below 0.5 T_{mel} were close to those determined by conventional tension tests. An exception was the region of temperatures close to the NDT temperature for the metals of the VIA group. (ATD)

8197 INVESTIGATION OF CREEP IN NIOBIUM ALLOYS BY THE TORSION METHOD. Prokoshkin, D. A.; Vasil'eva, E. V.; Chudarev, L. F. pp 124-7 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Creep investigations were made on samples of niobium–molybdenum, alloyed with titanium, boron, (up to 2%) and zirconium. The dependence of the deformation on time for different temperatures, obtained by conventional and temperature cycle methods is shown. The closeness of the values of the creep rate at the same temperature, by the two methods, indicates that the temperature cycle method can be used even in the case of complex alloys. To obtain comparative values of the creep rate, the temperature interval of the experiments was varied somewhat as a function of alloy. A semilogarithmic plot of the dependence of the deformation on temperature for a large number of different alloys is given. The values of the effective activation energy for creep can be determined from the slope of the straight line on the plot. It is not possible to establish a correlation between the activation energy for the creep and the activation energy for autodiffusion. (ATD)

8198 DISLOCATION CLIMB THEORY OF STEADY-STATE CREEP. Weertman, J. (Northwestern Univ., Evanston, Ill.). Amer. Soc. Metals, Trans. Quart., 61: 681-94(1968).

Evidence for the conclusion that any high-temperature creep theory must be based on the mechanism of self-diffusion is reviewed. Creep theories are reviewed in which the ultimate rate-controlling process is the mechanism of self-diffusion. These include the Nabarro–Herring creep of fine-grained material; subgrain creep based on the Nabarro–Herring theory and dislocation climb; Nabarro's creep theory of individual climbing edge dislocations; creep in which the major creep strain is produced by glide of dislocations but in which diffusion-controlled dislocation climb is the rate-controlling process; and creep in which diffusion control of jogs on screw dislocations is the rate-controlling process. (auth)

8199 INTERDIFFUSION BETWEEN NICKEL AND URANIUM. Kimmel, G. (Israel Atomic Energy Commission, Tel-Aviv); Bar-Or, A.; Rosen, A. Amer. Soc. Metals, Trans. Quart., 61: 703-10(1968).

The rate of growth of intermetallic layers between uranium and nickel was investigated using nickel plate/uranium diffusion couples. The experiments were carried out within the α temperature range of uranium. Using light metallography and microprobe analysis, three phases were identified: U_6Ni, U_7Ni_9, and UNi_5. No concentration gradients were observed in any phase. A model is proposed to calculate the activation energies for interdiffusion in the various phases. (auth)

8200 ELECTRICAL RESISTIVITY ANOMALY IN NICKEL-BASE ALLOYS. McCoy, H. E. Jr.; McElroy, D. L. (Oak Ridge National Lab., Tenn.). Amer. Soc. Metals, Trans. Quart., 61: 730-41(1968).

The electric resistivity of eight commercial nickel-base alloys containing iron, chromium, and molybdenum was measured to 1000°C. Alloys with more than 50 wt % Ni showed a rapid increase in resistivity between 400 and 600°C and a decreasing resistivity from about 600 to 1000°C. For these alloys the resistivity below 600°C can be changed by annealing and by cold working. The resistivity of alloys with less than 50 wt % Ni increased with temperature with a slope decrease between 400 and 600°C. The effects of annealing and cold working were relatively minor for these alloys. The resistivity variations observed do not seem to show a unique dependence on any one alloying constituent although there is a weak correlation with the total nickel content. Electron microscope results indicate that these changes may be associated with short-range order. (auth)

8201 DUCTILITY OF TEXTURED ZIRCALOY-2. Lee, D. (General Electric Research and Development Center, Schenectady, N. Y.). Amer. Soc. Metals, Trans. Quart., 61: 742-9(1968).

The roles of stress state and texture in fracture strain were examined in plane strain tension both at room temperature and 350°C in Zircaloy-2 sheets having different textures. Characterizing the material anisotropy by the transverse strain ratio, R, and by preferred orientation using x-ray methods, it was shown that the effective fracture strain, ϵ_f, in plane strain tension decreased with increasing R. Concurrently, the level of strength increased. Fracture occurred in ductile manner in shear, and from the constant level of fracture stress observed both at room temperature and 350°C, respectively, it was inferred that the ductility limit was controlled by the level of stress. From both ductility variation and fractographic studies, evidence was presented for a strong strain rate dependence at 350°C, overriding the effects found from texture alone. (auth)

8202 SOME OBSERVATIONS ON DISCONTINUOUS YIELDING IN ZIRCALOY-2. Edmonds, D. V.; Beevers, C. J. (Univ. of Birmingham, Eng.). J. Nucl. Mater., 28: 345-8(1968).

Results of an investigation of the influence of grain size, specimen texture, test temperature, and H_2 additions on the yield characteristics of Zircaloy-2 are reported. These results are compared with those from a similar investigation of very-high-purity Zr. The results for Zircaloy-2 show the same trend of yielding characteristics as those observed in high-purity Zr and are consistent with current ideas on polycrystalline yield behavior. (B.L.M.)

8203 OBSERVATIONS ON SURFACE CRACKS AND FRACTURE SURFACES OF CEMENTED CARBIDES. Hayashi, Kozi; Susuki, Hisashi; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 32: 997-1003(1968). (In Japanese).

Observations on surface cracks and fracture surfaces were carried out for various cemented carbides, using optical and electron microscopes, respectively. Specimens having 20% binders of Co, Ni, and Fe were sintered. Their grain size was fixed at 75 to 149 μ for the study of surface cracks, and at 75 to 149, ~44 and 1 to 2 μ for the study of fracture surfaces. Surface cracks were produced by the Vikers-indentor, and fracture surfaces, by bending-rupture. In each alloy having the coarsest grain size, on the portion of the surface subjected to tensile stress, initial cracks formed mainly in carbide grains, accompanied by almost no slip lines in both carbide and binder phases. On the sheared portion, however, cracks formed preferentially in

the binder, with numerous slip lines in both phases of the alloys excepting WC–Fe alloy. As for the surface or interior cracks formed under tensile stress, various types of propagation were observed. In WC–Ni alloy, the propagation occurred very easily along the carbide-binder interface; in WC–Fe alloy, along the double carbide-binder and carbide interfaces, or through the double carbide; in WC–Co alloy, generally through the binder and rarely along the carbide-binder interface. Therefore, the resistance to crack propagation should be largest in WC–Co alloy considering the plastic deformation of the binder, leading to the superior strength of that alloy. In WC–Co alloys, cleavage fracture of the ϵ' (hcp) phase, transformed from the γ (fcc) binder phase before the occurrence of fracture, was not often observed, probably due to the small amount of the ϵ' phase. (auth)

8204 EFFECT OF POLYGONIZATION ON THE HEAT RESISTANCE CHARACTERISTICS OF MOLYBDENUM. Demina, E. L.; Bernshtein, M. L. pp 84-6 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Specimens of sintered-molybdenum wire, 1.00 mm in diameter, were drawn at 300 or 1150°C with 5, 9, or 13% reduction, vacuum annealed at 1150°C for 1 hr, and subjected to stress-rupture tests at 900°C under a stress of 20 kg/mm^2. The rupture life was found to increase with increasing reductions. For instance, specimens drawn at 1150°C with 5% reduction and then annealed at this temperature for 1 hr withstood 95 min, while specimens reduced by 9 or 13% and annealed withstood 240 or 585 min respectively. The annealing of deformed molybdenum stimulates the formation of a polygonized structure which has a high creep resistance. However, with drawing at low temperature or with lower reduction, the polygonization is not completed after 1 hr at 1150°C. Only drawing with 13% reduction at 1150°C, followed by annealing at the same temperature produces a complete polygonization and the highest increase of rupture life. This mechanothermal treatment, which creates a polygonized structure, also substantially improves the ductility. For instance, the maximum elongation of molybdenum deformed at 1150°C with 9% reduction and annealed at 1150°C is 24% compared with 8% for molybdenum deformed at 300°C and tested without being annealed. Specimens deformed at 300°C with 5 and even 13% reduction also have a lower ductility. (ATD)

8205 ELECTRIC CONDUCTIVITY OF THE LANTHANUM–CERIUM SYSTEM IN THE SOLID AND IN THE LIQUID STATE. Gaibullaev, F.; Regel', A. R.; Khusanov, Kh. (Semiconductor Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 1742-4 (Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2220-2 (July 1968).

The temperature dependence of the electric conductivity of La containing 0 to 10 wt % Ce was measured at 0 to 1200°C; an electrodeless technique and Ta crucibles were employed. The change in the conductivity accompanying the melting at ~900°C is very small, falling within the limits of experimental error. Isothermal curves show only small effects of Ce % on the conductivity; broad, weak maxima are found at ~4% Ce on the 20 and 100°C curves. The s and d shells and the conductivity mechanism are discussed briefly. (D.L.C.)

8206 ADSORPTION, MIGRATION, AND EVAPORATION OF YTTRIUM ON A TUNGSTEN SINGLE CRYSTAL. Palyukh, B. M.; Sivers, L. L. (L'vov State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 1585-8 (Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2018-21 (July 1968).

A field-emission microscope has been used to study the behavior of yttrium on a tungsten single crystal at 300°K and higher, when active migration takes place followed by evaporation of the yttrium. The work functions φ of the yttrium–tungsten system have been measured in relation to the time of yttrium deposition and the temperature of the point. The activation energy of migration has been obtained in the absence of a field, and the effect of autoelectronic and autoionic fields on the activation energy has been investigated. (auth)

Structure and Phase Studies

Refer also to abstracts 7707, 8131, 8133, 8143, 8153, 8160, 8164, and 8195.

8207 (BARC-343) X-RAY DIFFRACTION EFFECTS ARISING FROM STACKING FAULTS IN ALPHA URANIUM. Krishnan, R. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 11p. Dep.

Line profile analyses on cold-worked uranium were carried out previously. The values of the particle sizes reported were 465 Å in the direction perpendicular to the (111) plane and 330 Å in the direction perpendicular to the (112) plane, for 60% cold-rolled uranium. Using these values the value of α turns out to be 1/1016, which is negligible. This is perhaps to be expected as the 2 Δ faults can result only from the slip system [001] ⟨100⟩. This slip system is not the predominant one in alpha uranium (the most predominant one is {010} ⟨100⟩. The values of the fault parameters obtained should be taken only to indicate the relative order of magnitude rather than the absolute value. (J.C.W.)

8208 (CONF-681020–(Vol.1), pp 207-19) COMPARATIVE ANALYSIS OF THE SILVER-RICH ALLOYS IN THE RARE EARTH–SILVER BINARY SYSTEMS. McMasters, O. D.; Alexander, D. G.; Venteicher, R. F. (Ames Lab., Iowa).

The solid solubility of rare earth metals, including yttrium and scandium, in silver was determined by the x-ray parametric method. Differential thermal analyses yielded the temperature of the silver-rich eutectic reaction in these systems. The stoichiometry of the intermetallic compound richest in silver in each system was determined by metallographic techniques. X-ray powder diffraction methods were used to investigate the crystal structures and to determine the lattice parameters of these compounds. Both europium and ytterbium tended to retain their elemental divalent character in these alloys. A correlation between the solid solubility data and the silver richest compounds is discussed. (auth)

8209 (CONF-681020–(Vol.2), pp 473-84) IRON–RARE EARTH INTERMEDIATE PHASES. Ray, A. E. (Dayton Univ., Ohio. Research Inst.).

A crystallographic study of the intermediate phases formed between iron and the rare earths, including yttrium but excluding europium and ytterbium, is reported. Crystallographic data are given for forty binary phases divided among five structural types. The number of phases in the various systems increases with decreasing rare earth size. No intermediate phases exist in the La–Fe system. A single intermediate was observed in both the Pr–Fe and Nd–Fe systems, while the Ce–Fe and Sm–Fe systems each contain two. The remaining systems each contain four intermediate phases except for Y–Fe, Tb–Fe, and possibly Gd–Fe, which contain five. A phase diagram for the Pr–Fe system is proposed. (auth)

8210 (CONF-681020–(Vol.2), pp 499-510) CRYSTALLOGRAPHY OF BINARY INTERMETALLIC COMPOUNDS OCCURRING NEAR THE TEN ATOMIC PERCENT RARE EARTH COMPOSITION. Johnson, Quintin; Smith, Gordon S. (California Univ., Livermore. Lawrence Radiation Lab.).

One of the disparate-composition regions favored by rare earth elements in combination with other smaller size elements occurs at about 10 at. % rare earth. Two crystal structures are important at this composition; both are described in a manner that leads to the A_2B_{17} formulation (where A is a rare earth element). These are the Th_2Zn_{17} structure type, characterized by the space group $R\bar{3}m$ and hexagonal c/a ratio ~1.5 (more precisely, 1.46), and the "Th_2Ni_{17}" structure type characterized by the space group $P6_3/mmc$ or $P6_322$ and a c/a ratio ~1.0. The former is well established by the results of five single crystal studies. The latter is less well understood and the composition of this phase should not be accepted blindly. Only one definitive single crystal study has been carried out so far; the formulation that resulted from that study is $AB_{10.3}$. When carefully examined, most of the AB_X compounds with compositions in the range of $7 < X < 11$ can be shown to have one of these two structures. At least two other structures also occur but less frequently. They are the Pu_3Zn_{22} and Ce_5Mg_{41} structure types. (auth)

8211 (CONF-681020–(Vol.2), pp 541-9) PHASE TRANSFORMATIONS ASSOCIATED WITH THE Sm-TYPE STRUCTURE IN THE Gd–Ce SYSTEM. Koch, C. C.; McHargue, C. J. (Oak Ridge National Lab., Tenn.).

Results are presented of a preliminary investigation into the nature of rhombohedral (Sm-type) structure found in many binary intra rare earth alloys. Alloys in the Cd–Ce binary system were prepared ranging in composition from 12 to 40 at. % Ce. The phase transformations were studied by electrical resistance measurements as a function of temperature. The structure and phase morphology were followed by x-ray diffraction and optical and electron microscopy. Critical temperatures for the apparent phase transformations were determined by the electrical resistance measurements. (auth)

8212 (GEMP-639) MICROSTRUCTURE OF ARC-CAST TUNGSTEN AFTER HIGH-TEMPERATURE CREEP DEFORMATION. Rau, R. C.; Bartram, S. F.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). [1967]. Contract AT(40-1)-2847. 24p. (CONF-681018-1). Dep. CFSTI.

From Symposium on Dislocation Climb and High Temperature Processes, ASM, Detroit, Mich.

Microstructural studies have been carried out on wrought, arc-cast, polycrystalline tungsten after creep-rupture testing at stress levels ranging from 0.21 to 5.62 kg/mm^2 at 1600 to 3000°C. Using optical and electron microscopy and Laue x-ray diffraction techniques, the subgrain sizes, dislocation densities, and subgrain boundary tilt angles and dislocation contents were determined and correlated with the creep conditions. These observations showed that subgrain sizes were independent of test temperature and were inversely related to creep stress, that the density of free dislocations depended upon both temperature and stress, and that subgrain misorientations were generally small, averaging less than 0.5°. Crystallographic analysis indicated that tilt, twist, and mixed type subgrain boundary dislocation networks were formed during creep. These networks were composed principally of dislocations having a/2 ⟨111⟩ Burgers vectors, with short a ⟨100⟩ segments at nodal points. (auth)

8213 (ORNL–4370, pp 9-12) DEFORMATION OF CRYSTALLINE SOLIDS. Williams, R. O. (Oak Ridge National Lab., Tenn.).

Textures and other structural information on Cu and Fe foils deformed by rolling, including high deformations under unusual conditions, were studied. A general investigation of deformation in hexagonal-close-packed metals was begun directed toward relating deformation substructures and work-hardening in Re. Primary theoretical consideration is given to dislocation-twin interactions in hexagonal metals in general. A new series representation is proposed for the thermodynamics of binary solutions. (auth)

8214 (ORNL–4370, pp 45-6) SUPERCONDUCTING MATERIALS. Love, G. R. (Oak Ridge National Lab., Tenn.).

The decomposition of single-phase Tc –30 at.% V alloys at 900°C gave a series of structures consisting of one superconducting phase dispersed in another. The critical temperatures, critical fields, and critical current densities of these structures were determined and the variation in these properties related to the developing structures. An analytic expression for the variation of superconducting critical current density with applied field and temperature was developed. The investigation of transformation kinetics and morphologies in rare earths was extended to rare earth alloys and the growth of high-purity La crystals. (auth)

8215 (ORNL–4370, pp 55-8) X-RAY DIFFRACTION. Yakel, H. L. (Oak Ridge National Lab., Tenn.).

Refined techniques for band-theory calculations were used to determine properties of Cu, Al, and Au, and to extend the method to more complex solids. Calculations on the electronic states were also carried out for metal atoms, C in n-electron systems, and He. (auth)

8216 (ORNL–4370, pp 156-60) ZIRCONIUM METALLURGY. Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.).

The anisotropy of uniaxial and biaxial plastic properties of Zr alloys to crystallographic texture was related. The orientation of the hydride in Zircaloy tubing to texture was also related. Deformation studies in single crystals showed how the development of texture is controlled by the fabrication stress state and the availability of slip and twinning modes. Inhomogeneous deformation was observed in Zr alloy tubing and its origin was identified as variations in texture around the tubing. Variations in texture were also found through the tubing wall. The texture variations are strongly influenced by processing history. An experimental tubing fabrication study is in progress to relate, in detail, fabrication variables to texture and thereby to permit texture control in commercially fabricated material. (auth)

8217 INVESTIGATIONS BY NEUTRON DIFFRACTION UTILIZING WHITE NEUTRON RADIATION. Schade, Arlen Ray. Rolla, Mo., Univ. of Missouri, 1968. 279p.

Thesis.

The most probable reactor core neutron velocity was determined by analysis of data obtained from single crystals of copper and lithium fluoride. Derivation of the relationship between the maximum in experimental count rate and the most probable velocity, an error analysis of the method, and the computer routine are given to obtain the most probable velocity which was used to index the maxwellian distributions from polycrystalline materials. Investigations were also done using White neutron radiation of various silicon steel samples of different preferred orientation. A method is described by which the preferred orientation of samples may be easily determined. This method involves analysis of maxwellian distributions and rocking crystal curves for various important sample directions, e.g., rolling direction, rolling direction +45°, and cross rolling direction. A computer program is given which will determine the full width at half maximum for a rocking crystal curve and a method to relate this to the grain distribution about a mean orientation. With sufficient data points, pole figures can easily be constructed for orientations of any type. The amount of data necessary is inversely proportional to the degree of preferred orientation of the sample. The effects of the stacking of sheets of samples were investigated. It is feasible to determine the average orientation of large numbers of thin sheets of silicon steel by investigation of the samples as a stack. The method used has several advantages over x-ray methods such as: samples of greater thicknesses can be investigated, a larger portion of the sample can be examined without oscillating the sample, and groups of samples can be investigated at the same time for a uniform preferred orientation. (Disser. Abstr.)

8218 PROBLEMS IN THE DETERMINATION OF HYDRIDE ORIENTATION IN ZIRCALOY TUBES. Mueller, Norbert; Vock, Ingrid (NUKEM, Wolfgang, Ger.). At. Strom, 14: No. 6, 88-90 (June 1968). (In German).

The hydride orientation factor F_N is an important quality characteristic for zircaloy cladding tubes. Various methods for the determination of the hydride orientation are described and discussed. In order to obtain generally comparable values, a normalization of the methods used is proposed, especially in the evaluation methods. In continuous normalization and careful determination, the F_N factor can be determined accurately to approximately ±0.03. Results from the manufacture of fuel rods for nuclear reactors are reported. The F_N factor can vary significantly within one and the same tube. In tubes of low quality, severe testing is necessary in the case of very rigid specifications. (tr-auth)

8219 EFFECT OF OXYGEN ON THE REGION OF EXISTENCE OF UC PHASES. Boncoeur, M.; Magnier, P.; Accary, A. (CEN, de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 28: 233-4(1968). (In French).

The phase limit between the $\overline{UC}$ phase and the U + $\overline{UC}$ region was determined as a function of $\underline{x} + \underline{y}$ by admitting the UC phases correspond to a formula of the type $U(C_{\underline{x}}, O_{\underline{y}}\square_{1-\underline{x}-\underline{y}})$. The limits of error were made more precise than in the previous studies. The points of the previous authors at a temperature below 1600°C are in agreement with the present results. The cause for the divergences is probably oxygen substituted for the carbon of the monocarbide. The limits of error show that, at least at temperatures above 1300°, the $\overline{UC}$ phases in equilibrium with uranium has a metalloid atom fault with respect to stoichiometry. The composition parameter which should be used for the establishment of the equilibrium diagram is the sum $\underline{x} + \underline{y}$ (and very probably $\underline{x} + \underline{y} + \underline{t}$). (J.S.R.)

8220 PRINCIPLES OF PHASE DIAGRAMS IN MATERIALS SYSTEMS. Gordon, Paul. McGraw-Hill Series in Materials Science and Engineering. New York, McGraw-Hill Book Company, 1968. 244p. $10.75.

The principles of equilibrium-phase-diagram relationships in one- and two-component materials systems are examined. The thermodynamic foundations of the diagrams are developed on the basis of the free-energy criterion with temperature, composition, and pressure as the relevant variables. Quasi-chemical and other atomistic viewpoints are introduced. Kinetic and nonequilibrium concepts and phenomenological discussions are included. (J.C.W.)

8221 HYDRIDE PRECIPITATES IN ZIRCONIUM ALLOYS. Ells, C. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 28: 129-51 (Nov. 1968).

The physical appearance of the room temperature hydride phase in zirconium alloys, with particular reference to the orientation of the hydride platelets relative to specified reference directions is described. Much of the experimental work has been on the commercial alloy Zircaloy-2, and for this alloy most of the observations reported are shown to be internally consistent. For this reason, fabrication routes designed to result in specific hydride orientations can be stated with some confidence. However, understanding of the mechanisms affecting hydride platelet orientation is relatively incomplete. (auth)

8222 RESULTS OF VISCOUS DISPLACEMENT OF GRAIN BOUNDARIES DURING CREEP IN URANIUM OF NORMAL NUCLEAR PURITY. Collot, J.; Cizeron, G. (Center of Metallurgical Research at the School of Mines, Paris). J. Nucl. Mater., 28: 195-201 (Nov. 1968). (In French).

Viscous displacement at grain boundaries during creep in uranium of normal nuclear purity is investigated. It was shown that at a temperature near $\frac{1}{2}T_f$ deformation by viscous displacement at grain boundaries seems to be of negligible importance in comparison with intergranular slip. The creep conditions which are known to be favorable, in other metals, for grain boundary displacement, i.e., a temperature above $\frac{1}{2}T_f$ low load, low creep

rate, and small grain size were established. It was shown that the phenomenon for uranium is qualitatively identical with that observed in other metals, but that in a quantitative sense its role seems distinctly less important than in other metals. This is no doubt due to the poor purity of the uranium used in these experiments. (tr-auth)

8223 CATION SELF-DIFFUSION IN UO_2. Reimann, D. K.; Lundy, T. S. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 28: 218-19(Nov. 1968).

Diffusion coefficients of uranium in polycrystalline UO_2 were measured previously. Single crystals prepared by floating-zone techniques were used in an attempt to measure cation self-diffusion coefficients of UO_2 at 985 to 1400°C. The method is described. No penetration of tracer could be detected after repeated heat treatments. In an experiment using polycrystalline specimens with large and small grain size, tracer penetration was found in the spectra where the grain size was small. A listing of 7 references is given. (J.C.W.)

8224 LATTICE PARAMETERS OF VARIOUS SERIES OF PSEUDO-BINARY RARE-EARTH-TRANSITION METAL LAVES PHASE COMPOUNDS. Christopher, J. T.; Piercy, A. R.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Less-Common Metals, 17: 59-63(Jan. 1969).

Measurements were made of lattice parameters in several series of substituted rare earth–transition metal Laves phase compounds. It was found that a general curve may be used to represent the variation of the lattice spacing in those compounds that contain iron. Most of the specimens examined showed a positive deviation from Vegard's Law for the cubic C_{15} structure. In addition however, the hexagonal C_{36} phase was found to coexist in some compounds and the atomic volume of this phase showed a negative deviation from a linear interpolation between the terminal phases. (auth)

8225 OBSERVATIONS OF ETCH PITS AND SUB-BOUNDARIES IN NIOBIUM BY OPTICAL MICROSCOPY. Pelleg, J. (National Research Council, Ottawa). J. Less-Common Metals, 17: 130-2(Jan. 1969).

Structural defects in well-annealed crystals of niobium were investigated. The crystals were etched and etch pit formation was observed. (M.C.G.)

8226 ON THE KNOWLEDGE OF MAGNESIUM–EUROPIUM SYSTEMS. III. THE PHASE DIAGRAM OF Mg–Eu SYSTEMS. Muehlpfordt, Werner; Klemm, Wilhelm (Univ., Munster, Ger.). J. Less-Common Metals, 17: 127-9(Jan. 1969). (In German).

Thermal analyses were made of phases in the Eu–Mg alloy. The stabilities of congruently melting compounds appearing in the system were determined. (M.C.G.)

8227 POLYTHERMIC SECTIONS OF THE Mo–Ti–Zr PHASE DIAGRAM. Zakharova, M. I.; Prokoshkin, D. A. Izv. Akad. Nauk SSSR, Metal., No. 2, 219-23(1968). (In Russian).

A series of ternary molybdenum–titanium–zirconium alloys was melted from 99.9%-pure molybdenum, 99.87%-pure iodide zirconium, and 99.85%-pure titanium. Alloys containing up to 50 at. % Mo were levitation melted in a helium atmosphere; the most refractory alloy compositions containing more than 50 at. % Mo were arc melted with a nonconsumable electrode in an argon atmosphere at a pressure of 150 mm Hg. Alloy specimens were vacuum annealed at 600, 750, 800, and 900°C for 1500, 900, 600, and 450 hr, or at 1200 and 1400°C for 175 and 100 hr, respectively, and quenched from these temperatures. Phase and microstructure analyses and hardness and microhardness measurements of individual phases were done on alloys located along the polythermic sections of the Mo–Ti–Zr system at a titanium content of 10, 20, and 30 at. %. On the basis of the obtained data, phase diagrams for the above polythermic sections of the Mo–Ti–Zr system were plotted. It was established that combined alloying with titanium and zirconium significantly lowered the melting temperature of molybdenum. Alloying titanium and zirconium with molybdenum stabilized the β-phase relative to the low-temperature modification of the α-phase. The α-phase region existed only at the polythermic section with 10 at. % Ti between 600 and 680°C, and extended only up to 0.3 at. % Mo from the Zr–Ti side. The regions of homogeneous β-solid solutions (β, β_1, β_2) in the polythermic sections of the phase diagram significantly increased with increasing titanium content. At the highest (30 at. %) titanium content, a region of a continuous series of solid solutions existed on the phase diagram at temperatures above 1450°C. (ATD)

8228 USING THE THERMAL ELECTROMOTIVE FORCE METHOD IN RESEARCH INTO Zr–Nb ALLOYS. Zuev, M. T.; Bychkov, Yu. F.; Rozanov, A. N. Met. Mealloved. Chist. Metal., Sb. Nauch Rabot, No. 6, 75-81(1967). (In Russian).

Thermoelectric effects were investigated in Zr-base alloys containing up to 40% Nb. The critical current density j_k of these alloys is highly influenced by their heat treatment and hence the reasons for the variation in j_k following tempering can be elucidated by investigating the changes in structure and properties—including thermal emf—that occur during tempering. The measurements of thermal emf were performed on tempered wire and rod specimens with the aid of a dc potentiometer with respect to Cu. One end of the alloy–Cu thermocouple was immersed in liquid nitrogen and the other end was kept at room temperature. Such a low-temperature method of measurement is highly simple and convenient, since then the specimen becomes neither oxidized nor subject to additional phase transformations; the required constant temperature gradient sets in quickly. Findings: the tempering-induced kinetics of variation in the thermal emf depends on the stability and properties of the phases that had existed in the original alloy. Thus, e.g., following tempering at 400°C, thermal emf changes differently for alloys of different composition: In the alloys with 8–13% Nb, which contain the ω-phase, thermal emf decreases (owing to the $\omega \rightarrow \alpha$ transition), whereas in β-solid solutions with 25 to 30% Nb, thermal emf increases owing to the increase in the content of the ω-phase segregating due to decomposition of β-phase; in the β-solid solution with 40% Nb, thermal emf remained unchanged, i.e., no ω-phase at all forms in that solution at 400°C. In specimens tempered at other temperatures, the pattern of variation in thermal emf is also different. These findings can be utilized as a means of verifying the structural homogeneity of superconducting wire after tempering and hence also correspondingly adapting the techniques of melting and heat treatment in order to produce wire with stable superconducting properties. Wire with a fixed and unvarying thermal emf along its entire length displays high superconducting properties, whereas wire with a variable thermal emf is defective. Thus the thermal emf of Zr–Nb alloys depends to a large degree on their phase composition and hence measurements of thermal emf can be a means of (1) determining the variations in phase composition during tempering and (2) verifying the homogeneity of heat-treated Zr–Nb alloy wire. (ATD)

8229 ELECTRONOGRAPHIC INVESTIGATION OF THE CARBONIZATION OF THIN FILMS OF TUNGSTEN ANNEALED IN VACUUM AT HIGH TEMPERATURES. Ivanova, R. S.; Ignatov, D. V.; Zaitsev, A. A. pp 290-2 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The experimental samples were thin films of tungsten (thickness 400 Å), produced in a vacuum of 3×10^{-6} torr by vaporization and condensation on a support. The supports used were sheets of mica and lumps of sodium chloride. The tungsten spiral for vaporization was made from a wire with a diameter of 150 mm, and was 15 mm long and had a diameter of 1.5 to 2 mm. The mounted spiral was etched in a mixture of nitric and hydrofluoric acids. Before vaporization the spiral was degassed by heating with an electric current in a vacuum of 10^{-5} to 10^{-6} torr. The tungsten films, with a thickness of 400 to 500 Å, were separated from the supports by immersing the mica sheets or the sodium chloride in a cup of distilled water. The films were washed by transfer to another cup of pure water. The tungsten films were heated in the temperature interval of 800 to 1800°C in a vacuum of 10^{-4} to 10^{-6} torr, by an electric current. The phase composition of the films determined by the electronographic method showed that tungsten films heated in a vacuum of 10^{-4} torr without the use of traps cooled by liquid nitrogen, at temperatures of 900 to 1000°, are transformed within 1 hr into the carbides W_2C and WC; at 800°, W_2C is observed in the amount of approximately 30%; even for films heated in a vacuum of 3×10^{-6} torr, with the use of two traps cooled by liquid nitrogen, in the temperature interval from 1000 to 1700°, there is present a mixture of W_2C and WC. (ATD)

8230 WROUGHT HEAT-RESISTANT ALLOYS OF Nb–Ni–Al SYSTEM. Mints, R. S.; Tsypkina, E. D.; Sipina, M. P.; Malkov, Yu. S. pp 200-1 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The phases of the Ni–Ni_3Al–Ni_3Nb system have been investigated in a search for wrought heat-resistant alloys consisting of γ'-phase strengthened by niobium. Microstructure and x-ray diffraction analyses revealed the existence of three regions in the Ni–Ni_3Al–Ni_3Nb system at niobium contents of up to 20%: a single-phase region of a nickel-base γ-phase, another single phase region of Ni_3Al, and a two-phase $\gamma + \gamma$ region. The most heat-resistant ternary alloys are located in the two-phase region. These alloys have a uniform, finely dispersed microstructure. One such alloy had a tensile strength of 106 to 119 kg/mm^2, an elongation of 10 to 20%, a reduction of area of 18 to 30%, and an

impact strength of 6 to 12 mkg/cm^2. In view of high characteristics of ductility, some additional alloying can be used to increase strength. (ATD)

8231 FINE STRUCTURE AND PROPERTIES OF SINGLE CRYSTALS OF TUNGSTEN. Savitskii, E. M.; Tsarev, G. L. pp 118-23 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Single crystals of tungsten with a diameter of 4 mm and a length of approximately 250 mm were grown by electron beam zone melting, at a rate of displacement of the melting zone of about 5 mm/min, and at a working vacuum of 5×10^{-5} mm Hg. The number of passes varied from 1 to 9. The impurity content in the single crystals is shown. Oxygen was determined by the method of vacuum melting, carbon by the combustion method, and the metallic impurities spectroscopically. For purposes of electron microscope examination, thin films were prepared by electrolytic polishing in a 2% NaOH solution. Experimental results are exhibited in tabular form. The following conclusions were reached: in single crystals of tungsten grown by electron beam zone melting a cellular growth structure and individual separations of tungsten carbide, W_2C, are observed. The boundaries of the cells are enriched with carbides; under conditions of vacuum melting, tungsten oxides and nitrides are, evidently, completely dissociated and volatilized; zone melting of tungsten in a vacuum does not lead to elimination of carbon. With an increase in the number of passes, the carbon content increases somewhat, while the carbides take on a coarser grain structure; increase in the number of passes leads to purification from metallic impurities; and the ductility of the single crystals of tungsten is directly connected with the amount and the dimensions of the tungsten carbides. (ATD)

8232 SOME RELATIONSHIPS OF CONSTITUTIONAL DIAGRAMS OF IIIA–VIA TRANSITION METALS. Upadhyaya, G. S.; Samsonov, G. V. (Inst. of Materials Science, Kiev). J. Less-Common Metals, 17: 161-5(Feb. 1969).

The general relationships of the binary constitutional diagrams of transition metals of IIIA–VIA groups are discussed in terms of the arrangement of the valence electrons of the component metals into localized and non-localized parts, and the possibility of the formation of stable electronic configurations with minimum free energy. Increase in the non-localized fraction of valence electrons of component atoms gives rise to the formation of either continuous or limited solid solutions. The types of constitutional diagram formed by transition metals of the 5th and 6th periods with elements of a different group are very similar, but different from the corresponding systems formed by 4th period transition metals. (auth)

8233 CELLULAR DECOMPOSITION AND PRECIPITATION IN A SUPERCONDUCTING NIOBIUM–ZIRCONIUM ALLOY. Waldron, G. W. J. (General Electric Co., Ltd., Wembley, Eng.). J. Less-Common Metals, 17: 167-80(Feb. 1969).

Heat treatment of an annealed Nb–25% Zr alloy in the temperature range 600 to 900°C leads to a cellular transformation to two isostructural phases. The rates of cell growth are higher by a factor 10^7 to 10^8 than those calculated using the volume diffusion coefficient and cell-matrix interface diffusion therefore seems likely to be the rate-determining factor in the cellular decomposition. In an as-extruded Nb–25% Zr material, the cellular reaction nucleates both on stringers of a mixed carbide (Zr,Nb)C and at the boundaries of partially-recrystallized grains. When the as-extruded material is solution treated and quenched from 1500°C, fine scale sub-boundary and grain boundary precipitation occurs prior to the cellular reaction, and the kinetics of the latter are modified. (auth)

8234 FIFTY YEARS OF PROGRESS IN METALLOGRAPHIC TECHNIQUES. A Symposium Presented at the Sixty-Ninth Annual Meeting, American Society for Testing and Materials, Atlantic City, N. J., 26 June–1 July, 1966. ASTM Special Technical Publication No. 430. Philadelphia, American Society for Testing and Materials, 1968. 415p. $27.75. (ASTM-STP-430; CONF-660670).

Twenty papers were presented at the conference. Progress achieved during the last one-half century in the development of improved metallographic techniques is discussed under four broad headings. These are: progress in optical metallography; progress in x-ray diffraction methods; advances in electron metallography; and progress in electron microprobe analysis. (R.C.K.)

8235 REMARKS ON THE HABIT PLANES OF ZIRCONIUM HYDRIDE IN ZIRCALOY-2. Arunachalam, V. S. (Bhabha Atomic Research Centre, Bombay); Oestberg, G.; Lehtinen, B. J. Nucl. Mater., 28: 336-8(1968).

The reported observations of several authors on the determination of the habit-planes of ZrH_4 in Zircaloy-2 are reviewed. An electron-microscopy method used for the determination of habit-planes is discussed in some detail. (B.L.M.)

8236 GRAIN-SIZE REFINEMENT OF INGOT BERYLLIUM BY STRAINING UNDER HYDROSTATIC PRESSURE. Inoue, N. (Franklin Inst. Research Labs., Philadelphia); Conrad, H. Amer. Soc. Metals, Trans. Quart., 61: 847-9(1968).

Two materials were investigated: as-cast ingot and cast and extruded rod. The as-cast material with the columnar structure exhibited less twinnings and other evidence of plastic deformation than was depicted for the equiaxed as-cast specimen. Following compression straining, the as-cast specimens were annealed for 1 hr at 750°C, while the extruded material was annealed for 1 hr at 800°C. The as-cast material was incompletely recrystallized and the grain size ranged from 5 to 10 μ. The extruded material completely recrystallized to an equiaxed grain size of 30 μ. (M.C.G.)

8237 PRECIPITATION IN QUENCHED AND AGED BERYLLIUM INGOT SHEET. Fraikor, F. J.; Brewer, A. W. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Amer. Soc. Metals, Trans. Quart., 61: 784-9(1968).

An investigation was conducted on the effect of solution annealing, aging time, and temperature on precipitation in quenched and aged beryllium. The material used in this study was Be rolled into sheet from vacuum cast ingots. It was found that Be of this purity which was quenched from above 900°C and subsequently aged at 500 to 780°C precipitated fcc $AlFeBe_4$ and hcp $FeBe_{11}$. The kinetics of precipitation are quite rapid at 780°C and much slower at 500 to 650°C. Partially coherent platelets of $FeBe_{11}$ are visible after 5 min of aging time at 780°C whereas coherent particles with strain contrast are still visible after 10 to 20 hr at 650°C. Electron diffraction patterns and moiré fringe spacings on disk-shaped precipitates show that the coherent precipitates are predominantly $AlFeBe_4$ whose (111) planes are parallel to (0001) planes of the Be matrix. (auth)

8238 INVESTIGATION OF THE RECRYSTALLIZATION PROCESS IN TUNGSTEN. Rastegaev, M. V.; Danil'chenko, A. N.; Kashin, V. I.; Zharov, V. M.; Vasyukov, G. A. pp 109-12 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An investigation of vacuum melting of tungsten reduced with niobium is reported. The tungsten billets with a diameter of 35 mm were worked down on a lathe to a diameter of 16 mm and were cut into samples with a height of 39 mm. Upsetting of the samples was done in a hydraulic press with a degree of reduction of about 40%. The first part of the samples was subjected to stepwise annealing in a vacuum furnace (vacuum 10^{-4} mm Hg) at temperatures of 1250, 1400, 1600, 1800, and 2000°C for a period of 40 minutes. After each annealing, the samples were cooled in the furnace to 20°C; polished samples were then prepared and examined for degree of recrystallization. The experimental results are shown in a three dimensional diagram of the recrystallization of the cast structure of tungsten. Analysis of the results shows that 100% recrystallization of the cast structure in the samples, deformed by approximately 40% in the temperature interval from 400 to 1200°C, is completed at a stepwise annealing temperature of 2000°C. With direct heating (without steps) of the second part of the samples, although complete recrystallization was assured, the boundaries of the old crystals were retained. With annealing temperatures in the interval from 1400 to 1800°C, the cast structure recrystallized partially within the limits of 25 to 90%. At an annealing temperature of 1250°C, the cast structure of the samples deformed by 40% in the temperature interval 200 to 1250°C did not recrystallize. The cast structure, deformed at 200°C, did not recrystallize in the temperature interval from 1250 to 1600°C. However, in samples deformed at higher temperatures (800°C) partial recrystallization was observed. (ATD)

8239 SELF-DIFFUSION IN MONO- AND POLYCRYSTALLINE TUNGSTEN. Larikov, L. N.; Chernaya, L. F.; Yatsenko, T. K. pp 28-30 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An investigation of the volumetric and boundary autodiffusion of tungsten, using the radioactive isotope ^{185}W is reported. The study of volumetric autodiffusion was carried out on monocrystalline tungsten obtained by the electron radiation method. Diffusion annealing was done in the temperature interval 2430 to 2000°C in a Type TVV-4 furnace in an argon atmosphere. The diffusion coefficients were measured by the layer method, by measurement of the surface activity of the sample. A figure shows the temperature dependence of log D. This dependence can be described by the equation $D_{tot} = 25.12 \exp(151{,}000/RT)$. The experimental data are also shown in detail in tabular form. Diffusion annealing was carried out in a Type TVV-2m furnace in an argon atmosphere in the

temperature interval from 1730 to 1900°C. The data compared in a satisfactory manner with data from previously published work. (ATD)

8240 BINDER PHASE TRANSFORMATION IN WC–Co CEMENTED CARBIDES. Suzuki, Hisashi; Yamamoto, Takaharu; Sakanoue, Hitoyuki (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 32: 993-7(1968). (In Japanese).

The amount, distribution, and thermal stability of the ϵ' phase transformed in deformed superficial layers of the WC–Co alloys by abrasion were studied. The electron micrographs of a thin film of the deformed surface including the fracture surface were also studied. The two-phase specimens containing 10 to 20% Co and having the average grain size of about 1.4 μ were vacuum-sintered at 1345 to 1375°C for 1.5 hr. The amount of the ϵ' phase increased with increasing abrasion time, and it reached a maximum constant value after the abrasion of more than 4 to 5 min. This maximum value increased further in the alloy having higher Co and C contents, and also in the case of abrasion by a coarser diamond wheel. As for distribution of the amount of the ϵ' phase from the surface to the inside, peaks were found in each alloy at the depth of about 5 μ, with a sharp decrease at the further depth. A ($\epsilon' \rightarrow \gamma$) reverse transformation was observed to begin at temperatures above about 400 and 600°C in high and low C alloys, respectively. The transformation was completed at about 800°C in each alloy. The ϵ' phase formed on the abrasion or fracture surface was confirmed using transmission-electron microscope. (auth)

8241 REPLICA ELECTRON MICROGRAPHS OF A SPUTTERED DELTA-STABILIZED Pu ALLOY. Dahlgren, S. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 28: 333-5(1968).

Electron micrographs of a sputtered δ-phase Pu–1.2 wt % Ga alloy were obtained as part of a program to obtain fundamental information about the complex character of Pu and Pu-base alloys. Staining techniques on unalloyed α-Pu left the surface too smooth to replicate; however, replicas were obtained for the sputtered alloy both before and after annealing for two specimen orientations, one normal to and the other parallel with the direction of sputtered deposit growth. The micrographs indicate that the sputtered alloy consisted of long columnar grains having diameters on the order of 0.6 mμ before annealing and 1.8 mμ after annealing. (B.L.M.)

8242 EFFECTS OF ADDITIONS OF BERYLLIUM AND BOTH BERYLLIUM AND IRON ON $\beta \rightarrow \alpha + \gamma_2$ TRANSFORMATION OF COPPER–ALUMINUM ALLOYS. Hori, Masaiti (Kanagawa Univ., Yokohama, Japan). Nippon Kinzoku Gakkaishi, 32: 1003-7(1968). (In Japanese).

When Al-bronze is slowly cooled, it shows a brittleness called "self-annealing phenomenon of Al-bronze." This phenomenon is caused by γ_2 produced at $\beta \rightarrow \alpha + \gamma_2$ transformation. Therefore depression of the self-annealing phenomenon poses an important problem from the engineering point of view, and additions of Fe and Mn are effective on the depressing of $\beta \rightarrow \alpha + \gamma_2$ transformation. The depressing effects of additions of Be and both Be and Fe on the $\beta \rightarrow \alpha + \gamma_2$ transformation of Cu–Al alloy were studied. For this purpose, the TTT diagrams of these Cu–Al alloys were made out through examinations of microstructures. Isothermal transformations in the Cu–Al–0.66 Be–3.65 Fe alloy were slightly slower than in the Cu–Al–3 Mn alloy, and addition of Be was effective for the depressing of $\beta \rightarrow \alpha + \gamma_2 + \kappa$ transformation of Cu–Al–Fe alloy. (auth)

8243 INFLUENCE OF PRECIPITATION HARDENING AND RECRYSTALLIZATION ON THE TEXTURE OF F.C.C. ALLOYS. II. COPPER–BERYLLIUM. Grewen, J.; Scholz, B. (Institut fuer Metallkunde und Metallphysik, Clausthal, Ger.). Metall, 22: 1119-24(Nov. 1968). (In German).

The roll structure of copper and brass type as well as transition alloys can be explained better by ideal layers and that of limited thread structures only by ideal layers. In spite of various roll structures (brass type and transition type), preseasoned samples and samples deformed in the homogeneous state have the same annealed texture, which, with increasing precipitation orientations, increases corresponding to the roll texture. Just as in Cu–Cr, in Cu–Be precipitation before or simultaneously with the recrystallization causes a change of the texture. (tr-auth)

8244 IRREVERSIBLE PHASE TRANSITION AND COMPRESSIBILITY OF TERBIUM. Stephens, D. R.; Johnson, Q. (Univ. of California, Livermore). J. Less-Common Metals, 17: 243-6(Feb. 1969).

A study of phase transition and compressibility of Tb revealed an irreversible phase transition at ~25 kb with an irreversible volume change of ~0.6%. On subsequent loading and unloading cycles, the discontinuity in volume was not observed. Pressure-volume data indicate that Tb in the hcp phase is much more compressible than is transformed Tb. Experimentally determined densities are given. Structure of transformed Tb was analyzed by x-rays. The powder pattern of transformed Tb seems to indicate a Sm-like phase. (F.S.)

Radiation Effects

Refer also to abstracts 8113, 8161, and 8165.

8245 (ORNL–4370, pp 116-19) IRRADIATION DAMAGE TO ALUMINUM. Martin, W. R. (Oak Ridge National Lab., Tenn.).

Research was conducted on the type and magnitude of Al irradiation damage at high neutron fluences. It was found that high neutron fluences near 10^{22} neutrons/cm^2 resulted in embrittlement of X8001, 1100, and 6061 alloys when deformed within a specific elevated temperature range, even though no significant change occurs at room temperature. Increases in strength were also observed. Starting with a neutron exposure of 5×10^{21} neutrons/cm^2 the density increases linearly with increasing fluence. Irradiated in the Oak Ridge Research Reactor, 1100 Al decreased 1.5% in density at a fluence level of 1.5×10^{22} neutrons/cm^2. The irradiation produced about 10^{15} cavities/cm^3, with diameters in the range of 100 to 600 Å. Cavities most likely give rise to swelling and can be removed by annealing at 260°C for 1 hr. (auth)

8246 (ORNL–4370, pp 198-9) CLADDING MATERIALS FOR SNAP-8. Weir, J. R. Jr.; McCoy, H. E. Jr.; Harman, D. G. (Oak Ridge National Lab., Tenn.).

Radiation effects testing of Hastelloy X, Incoloy 800, type 304 stainless steel, and Hastelloy N is summarized. (J.R.D.)

8247 (ORNL–4370, pp 241-2) ARMY PULSED RADIATION FACILITY REACTOR ASSISTANCE. Litman, A. P. (Oak Ridge National Lab., Tenn.).

Metallurgical assistance to the APRFR Program is summarized. Information is included on evaluation of APRFR core, and core alloy development. (J.R.D.)

8248 EFFECTS OF REACTOR IRRADIATION ON THERMOCOUPLE MATERIALS. Pravdyuk, N. F.; Ivanov, A. N.; Dubrovin, K. P. At. Energ. (USSR), 25: 233-5(Sept. 1968). (In Russian).

Effects of reactor irradiation with 10^{19} to 10^{20} neutrons/cm^2, followed by annealing, on the properties of thermocouples made of copper, iron, constantan, nichrome, chromel, alumel, platinum, copel, platinum alloys with 13% rhodium, gold, gold alloy with 40% palladium and molybdenum were studied. Tabulated data on the thermo-emf (per 1°C) of irradiated materials showed variable effects on various thermocouples. The copper-copel, iron-constantan, chromel-copel, chromel-alumel, and nichrome-constantan thermocouples developed a reduced thermo-emf in comparison to non-irradiated. Thermoelectric properties of gold and platinum were less affected by fast and thermal neutron (10^{19} to 10^{20} neutrons/cm^2) irradiation than their alloys. Annealing at 100 to 700°C restored in most cases the original thermo-emf. (R.V.J.)

8249 EFFECTS OF POINT DEFECTS ON THE LATTICE PARAMETERS OF TEMPERED AND IRRADIATED Cu, Ni, AND Mo. Malinenko, I. A.; Shivrin, O. N. (Petrozavodsk State Univ., USSR). Fiz. Metal. Metalloved., 26: 184-6(July 1968). (In Russian).

Lattice parameter alterations in technically pure (not over 0.1% impurities) polycrystalline Ni, Mo, and Cu tempered (Ni and Mo at 1300° and Cu at 1000°C in water) and irradiated with 1.3 MeV γ rays at doses of 10^3, 10^4, and 10^6 r at 30°C were studied. Tabulated data on defects induced are analyzed. (R.V.J.)

8250 α IRRADIATION OF QUENCHED GOLD. Eades, J. A.; Rojo, J. M. (Cambridge Univ., Eng.). Phil. Mag., 18: 1097-1101 (Nov. 1968).

Thin foils of quenched gold containing tetrahedra were irradiated with α-particles of maximum energy of 3.2 MeV to doses in the range 1 to 15×10^{14} cm^{-3}. The foils were examined by electron microscopy before and after irradiation. A fraction (approximately proportional to dose) of the tetrahedra collapsed to form Frank loops; in no case was shrinkage of the tetrahedra observed. The collapse is explained as the radiation-activated collapse of a metastable defect to its stable form. Double tetrahedra also collapsed to form planar loops at a rate twice that for single tetrahedra. (auth) (UK)

8251 SATURATION AND EXPOSURE DEPENDENCE OF THE YIELD STRESS OF IRRADIATED IRON. McRickard, S. B.

(Brookhaven National Lab., Upton, N. Y.). Phil. Mag., 18: 915-22(Nov. 1968).

The yield stress data of irradiated Ferrovac iron are shown to be closely approximated by the expression $\Delta\sigma = A[1 - \exp(-B\phi t)]^{\frac{1}{4}}$ with a saturation exposure of 2×10^{19} nvt (E > 1.45 MeV). The maximum increment in the yield stress is 25,000 psi and the volume of the defect calculated from B is 4.4×10^{-19} cm^3. If the defect is considered a spherical depleted zone, this corresponds to a diameter of 95 Å and the actual defect is probably near 50 Å in diameter at saturation. Deviations at low exposures are explained on the basis of enhanced carbide precipitation. The mode of zone production and growth is believed dependent on the amount of available (mobile) carbon. (auth)

8252 APPLICATION OF AUTORADIOGRAPHY TO THE STUDY OF THE CATALYTIC ACTIVITIES OF Cu–Ni CATALYSTS. Takeuchi, Toyosaburo; Tezuka, Yoshisato; Miyatani, Daisaku; Nakajima, Yoshihumi; Aizumi, Hiro (Toyama Univ., Japan). Radioisotopes (Tokyo), 17: 549-54(Dec. 1968). (In Japanese).

The autoradiographic method was adapted for the investigation of the reactivity of the preadsorbed hydrogen or ethylene on Cu, Ni, and Cu–Ni alloys prepared by various methods. $^3H_2$ and ^{14}C-ethylene were used as the tracers. The damage effect caused by alpha particles and the effect of the sintering by the heat treatment on the adsorption were observed. Massive alloys and the evaporated films deposited on the cold substratum were used for the tests. A great difference was found on the amount of the adsorbed hydrogen between the massive alloys and the evaporated films. The amount of adsorbed hydrogen increased by the damage of alpha particles in the case of the massive metal and the film sintered at 250°C. However, the amount decreased in the case of the film sintered at 30°C. It was found that the amount of the adsorbed ethylene was not affected by the composition of the alloy. These results suggested that the catalytic activity of metals depends mainly upon the structural factor rather than the electronic factor of the metals. (auth)

8253 THE EFFECT OF RESIDUAL ELEMENTS ON THE RESPONSE OF SELECTED PRESSURE VESSEL STEELS AND WELDMENTS TO IRRADIATION AT 550°F. Potapovs, Uldis; Hawthorne, Russell (Naval Reseach Lab., Washington, D. C.). Nucl. Appl., 6: 27-46(Jan. 1969).

Effects of residual elements on radioinduced embrittlement of pressure vessel steels at 550°F were examined. Results indicate that phosphorus and copper can contribute significantly to embrittlement sensitivity of Type A302-B steel. The results also show that vanadium may have an adverse effect and that sulfur is neutral, although the latter serves to decrease the full shear energy absorption level of the steel. Nitrogen variations from ~0.008% to 0.015% in aluminum deoxidized steel have no significant effect, while the addition of aluminum to Ni–Cr–Mo steel with a given nitrogen content may slightly promote irradiation embrittlement. The program results demonstrate that apparent insensitivity to 550°F irradiation embrittlement can be consistently achieved with laboratory heats of a nominal A302-B steel composition by maintaining the total residual element contents at a low level. Investigations of radiation embrittlement sensitivity of weldments, aimed at development of low sensitivity weld fillers for joining Ni–Cr–Mo steel, again point to copper as a dominating factor in determining radioinduced embrittlement sensitivity, further verifying the results obtained in the NRL-USS A302-B steel investigation. Two experimental weld wire compositions with low copper contents (<0.1%) are shown to possess resistance to 550°F irradiation embrittlement equal or superior to that of A543 base plate. (auth)

8254 MOLTEN PLUTONIUM FUELS. Kirkbride, L. D. (Los Alamos Scientific Lab., N. Mex.). Met. Soc. Conf., 42: 353-75(1966).

Liquid Pu alloys are being investigated as fuels for large fast breeder reactors. Results of several research programs involved in developing the Pu–Co–Ce fuel system are discussed. One program is concerned with establishing a corrosion-resistant container for liquid Pu alloys. Another phenomenon under study is that of the creep of a fuel film up container walls and subsequent enrichment of the film in Pu. Experimental evidence indicates that formation of a Ta–Co intermetallic compound is responsible for the Pu enrichment. Techniques of prevention of the fuel creep and Pu enrichment are presented. A research program concerned with irradiation performance of liquid Pu alloy fuels is in progress. Irradiation results obtained are favorable. A brief description of some results obtained in LAMPRE-I (Los Alamos Molten Plutonium Experiment-I, a 1-MWt fast reactor, fueled with Pu–Fe eutectic alloy) is given. Current investigations are concentrated on the effect of fission product recoil on the damage to both Ta and Ta(W)-C layers by testing in the Omega West Research Reactor (OWR), a 5-MWt thermal flux machine. A significant finding is that at wall fission densities of up to 8×10^{20} fissions/cc, fission products recoiled into the Ta alloy container walls concentrated and diffused along particular crystallographic planes to a depth of <2.5 mils. (auth)

8255 EFFECT OF GAMMA RADIATION ON CERTAIN PROPERTIES OF THE ML5 MAGNESIUM FOUNDRY ALLOY. Meshkov, V. N.; Konozenko, I. D. (Inst. of Physics, Kiev). pp 128-40 of Izucheniye Defektov Kristallicheskogo Stroyeniya Metallov i Splavov. Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

Specimens of the ML5 naturally aging magnesium foundry alloy, taken from two melts (8.5 and 8.9 wt % Al, 0.40 and 0.55 wt % Zn, 0.16 and 0.2 wt % Mn, 0.085 and 0.25 wt % Si, 0.02 and 0.01 wt % Cu, 0.13 and 0.14 wt % Fe, with Mg as the remainder) were γ irradiated in cobalt installations at 20 ± 5 and 70 ± 5°C; the radiation doses ranged from 2.74×10^{15} to 1.883×10^{18} γ/cm^2. The first-melt specimens were taken from structural parts operated under variable loads and at variable temperatures for two years, while the second-melt specimens were taken from parts kept in storage over roughly the same period of time. Tests of mechanical properties showed that, both following operation and following storage, owing to natural aging the solid solution undergoes decomposition along with segregation of excess phases (chemical compounds formed by alloy elements with magnesium, such as $Mg_{17}Al_{12}$, MgZn, etc.). Gamma irradiation produced radiation defects which accelerated the diffusion processes contributing to the concentration of these segregations and hence also to embrittlement of the alloy, particularly when the irradiation was performed at higher temperatures (70°C). This embrittlement and deterioration in mechanical properties was greater the higher the γ-radiation dose. However, the mechanical properties of the alloy could be restored by annealing it at >325°C over prolonged periods of time. (ATD)

8256 EFFECT OF RADIATION ON CERTAIN CHARACTERISTICS OF NIOBIUM AND ITS ALLOYS. Markovskii, E. A.; Chernyi, V. G.; Tikhonovich, V. I.; Krasnoshchekov, M. M.; Nedyukha, I. M. (Inst. of Metal Physics, Kiev). pp 106-10 of Izucheniye Defektov Kristallicheskogo Stroyeniya Metallov i Splavov. Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The effects of radiation on the hardness of Nb and the alloys of Nb with Mo (25 wt %) and Fe (2.0, 3.0, 3.5 and 37 wt %), as well as on the antifriction properties of Nb, were studied. The specimens were irradiated in an atomic reactor with an integral neutron flux of 10^{19} neutrons/cm^2 or with γ-quanta from a γ-gun in a total dose of 5.3×10^5 R. Vickers hardness was measured by means of a diamond pyramid under a load of 20 kg and wear tests were performed in a laboratory setup. It was found that irradiation with γ-quanta does not affect the hardness of Nb and Nb–Mo alloy. Irradiation with neutrons on the other hand, affects the mechanical properties (hardness) of Nb and its alloys depending on their purity or chemical composition. Thus, the hardness of pure Nb (obtained from an electron-beam furnace) then nearly doubled, whereas the hardness of Nb containing 0.5% impurities remained nearly unchanged. The hardness of the Nb–Fe alloys containing 2.0, 3.0, and 3.5 wt % Fe increased slightly. On the other hand, irradiation of the Nb–Fe alloy containing 37 wt % Fe produced no change in its hardness. These differences in the hardness of the investigated materials following irradiation apparently are associated with the difference in the degree of their structural defects prior to irradiation: the least number of defects exists in pure Nb obtained from an electron-beam furnace; in case irradiation produces a large number of defects, which results in the increase in hardness. Apparently the neutron flux having the energy specified above produces additional defects in the material; if the material originally already contained a more or less large number of defects, as in the case of impure Nb and Nb–Mo alloys, neutron irradiation cannot produce many additional defects. As for antifriction properties, neutron irradiation somewhat changed these properties with specimens; this apparently is also attributable to the formation of additional structural defects in the specimens and the attendant change in the pattern of interaction between the surfaces of Nb and the body with which it is in friction. (ATD)

8257 INVESTIGATION OF THE PROPERTIES OF NEUTRON-IRRADIATED ML5 INDUSTRIAL FOUNDRY ALLOY. Meshkov, V. N.; Konozenko, I. D. (Inst. of Physics, Kiev). pp 122-7 of Izucheniye Defektov Kristallicheskogo Stroyeniya Metallov i Splavov. Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The effect of irradiation with an integral neutron flux on the properties of this magnesium-base naturally aging master alloy was investigated by means of tensile, impact and Brinell tests, in addition to a microstructural examination and measurements of

electrical resistance. It is established that the radiation-induced change in mechanical properties of ML5 alloy depends on the integral neutron flux and on the state of the alloy. Both during operation of parts made of this alloy and during their storage, decomposition of the solid solution with segregation of excess phases occurs, apparently owing to the natural aging of this alloy. Irradiation with an integral flux of 10^{19} neutrons/cm^2 reduces the alloy's electrical resistance and adversely affects its strength properties apparently owing to the formation of radiation defects and the concomitant increase in the rate of diffusion processes accelerating the segregation of the alloy-element compounds along grain boundaries; the attendant increase in the extent of the network of grain boundaries, i.e., in the number of grains surrounded by brittle particles of these segregations, results in the embrittlement of the alloy, and specific integral doses cause changes in properties that are dangerous from the standpoint of structural strength. It is also established, however, that subsequent prolonged high-temperature annealing of the irradiated alloys restores their original properties. (ATD)

Ceramics and Cermets

Refer also to abstracts 8106, 8107, 9257, 9262, and 9263.

8258 (GA–8538) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending February 14, 1968. Bokros, J. C.; Engle, G. B.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 21, 1968. Contract AT(04-3)-167. 50p. Dep. CFSTI.

ALUMINUM—use in catalytic graphitization
GRAPHITE—annealing of laminar, isotropic, and titanium-doped pyrolytic, properties produced by
—graphitization of, correlation of crystallite size and density in
—graphitization of, studies of catalytic
—radiation effects on dimensions of molded, effects of binder-coke content on fast-neutron
—thermal expansion measurements on molded
TITANIUM—use in catalytic graphitization
ZIRCONIUM—use in catalytic graphitization
ZIRCONIUM CARBIDES—use in catalytic graphitization (D.L.C.)

8259 (GA–8852) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending August 14, 1968. Bokros, J. C.; Engle, G. B.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 1, 1968. Contract AT(04-3)-167. 23p. Dep. CFSTI.

ALUMINUM—effects on catalytic graphitization
ASPHALT—graphitization of aluminum- and titanium-containing
CARBON—annealing of titanium-doped pyrolytic
—radiation effects on dimensions of, neutron
COKE—graphitization of aluminum- and titanium-containing
GRAPHITE—graphitization of, densitometric characterization of
—radiation effects on density of CHN and H-315-A, neutron
—annealing of irradiated pyrolytic, property changes induced by
NEUTRONS, FAST—effects on graphites and carbons
TITANIUM—effects on catalytic graphitization (D.L.C.)

8260 REFRACTORIES. FOURTH EDITION. Norton, F. H. New York, McGraw-Hill Book Company, 1968. 459p.

The scope including the statistics and future predictions for the industry are discussed. Uses of heavy brick, insulating materials, special shapes, mortars, plastics, concretes, and coatings and the production methods are summarized. Equipment and working methods are described. Properties discussed include fusion points, load-bearing capacity, spalling, resistance to slags and glasses, expansion, shrinkage, heat transfer, strength, and electric conductivity. A listing of references is included for each chapter. (J.C.W.)

8261 HIGH TEMPERATURE NUCLEAR FUELS. Holden, A. N. (ed.). Metallurgical Society Conferences. Volume 42. New York, Gordon and Breach, Science Publishers, 1966. 523p. $31.50.

The book is divided into 28 sections. A separate abstract was prepared for each section. (P.G.C.)

For abstracts of individual papers see: 8141, 8254, 8262, 8292–8295, 8314–8317, 8334, 8335, and 8349–8363.

8262 ENVIRONMENTAL DEMANDS OF HIGH-TEMPERATURE REACTORS. Fortescue, P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Met. Soc. Conf., 42: 3-10(1966).

The metallurgical factors involved in the design and operation of high-temperature, gas-cooled reactors are discussed in the areas of reduction of fuel cycle costs, influence of inlet temperature for single reheat cycles, limits to steam temperatures, and effects of long burnups on the economic performance. (P.G.C.)

8263 PYROLYTIC CARBONS DEPOSITED IN FLUIDIZED BEDS AT 1200 TO 1400°C FROM VARIOUS HYDROCARBONS. Bard, R. J.; Baxman, H. R.; Bertino, J. P.; O'Rourke, J. A. (Los Alamos Scientific Lab., N. Mex.). Carbon, 6: 603-16(Oct. 1968).

Pyrolytic carbons deposited in fluidized beds at 1200 to 1400°C from various hydrocarbon–helium mixtures using otherwise identical process parameters were compared. The trends of microstructure or density with increasing deposition rate were very similar at a given temperature. For each hydrocarbon investigated at 1400°C there was a minimum in the density vs deposition rate curve. Pyrolytic carbons deposited at 1200°C at similar initial rates near 10 μ/hr from seven hydrocarbon–helium mixtures (methane, ethane, ethylene, acetylene, propane, cyclohexane, and benzene) had very similar microstructures, densities, preferred orientations, and apparent crystallite sizes. The results support the view that pyrolysis of hydrocarbons in fluidized beds involves dissociation into small fragments which then take part in polymerization–dehydrogenation reactions, and indicate that the general mechanisms of pyrolytic carbon deposition in fluidized beds are independent of the hydrocarbon. The various microstructures are explained in terms of the extent of incorporation of gas-borne droplets or soot particles into the deposits or the variations of coating environment within the fluidized beds. The systematic variations of the properties of the pyrolytic carbons deposited from methane–helium mixtures at 1400, 1300, and 1200°C were investigated in detail and found to be consistent with a published model of pyrolytic carbon deposition in fluidized beds. (auth) (UK)

Corrosion and Erosion

8264 INVESTIGATION OF CRACKS AROUND VICKERS HARDNESS INDENTATION IN CEMENTED CARBIDES. Miyoshi, Akiyoshi; Hara, Akio; Sugimoto, Yoshinobu (Itami Research and Development Labs., Japan). Sumitomo Elec. Tech. Rev., No. 11, 120-3(Oct. 1968).

Effects of the lapping time on the crack length around Vickers hardness indentation were examined and the causes were studied by using various cemented carbides. In cemented carbide with WC phase, including a WC–0.2% Co alloy, a remarkable increase in the crack length in accordance with an increase in the lapping time was observed. On the contrary, in (W–Ti–Ta) C–Co alloys that contained no WC phase, such phenomenon was not observed. Microhardness measurements showed the same tendency. In the single crystal of WC a considerable dependency of micro-hardness on lapping time was observed. By changing the test load in hardness measurement, it was found that a depth of several microns of the surface was hardened by lapping. The dependency of the crack length on the lapping time is considered to be explained by the work-hardening of WC phase during lapping. (auth)

Preparation and Fabrication

Refer also to abstracts 7502, 7665, 8141, 8301, 8351, and 9265.

8265 (BMI–1851) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY–SEPTEMBER 1968. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1968. Contract W-7405-eng-92. 84p. Dep. CFSTI.

Developments are reported for studies on: the fabrication and cladding of UN–PuN fuels for LMFBR applications; radiation effects on fast-reactor cladding and structural materials; and creep testing of UO_2 and UO_2–PuO_2 fuel materials. (L.C.L.)

8266 (CEA-R-3524) ELECTRON BOMBARDMENT MELTING AND CONTINUOUS CASTING OF URANIUM CARBIDE. FUNDAMENTAL STUDY OF THE METALLURGICAL AND THERMAL PROCESSES. Trouve, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 78p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

About 1200 kg of uranium carbide cylindrical rods were prepared by electron bombardment fusion and continuous casting in

an apparatus making it possible to operate in a constant vacuum automatically. In order to make the most of the fusion technique used, it was necessary to resolve a certain number of problems. It was found that the energy yield for the electron bombardment heating using accelerating voltages of about 10 kV was 100%; about 40% of the electrons are re-emitted by back-scattering. These electrons leave the surface with practically zero energy. The fusion technique leads to the elimination of the majority of the metallic impurities. In order to explain the variations in the non-metallic impurity contents the different reactions occurring in the molten uranium monocarbide were determined. A micrographic study of the rods obtained has shown various types of crystallization depending on the rate of casting and, despite the uniaxial symmetry of the cooling, no texture has been observed, whatever the rate of fusion employed. The aspects of the fracture surfaces observed on certain rods can be explained by theory in the domain where the material is elastic. Furthermore, it has been shown that a decrease in the brittleness occurs as a result of the formation of fine precipitates of the Wiedmanstätten structure type. (auth)

8267 (CEA-R-3803) RECENT ADVANCES IN THE PRODUCTION OF MIXED, SINGLE-PHASE SINTERED CARBIDES (U–Pu)C. Lorenzelli, Robert; Petit, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 35p. (In French). Dep.

The (U–Pu)C sintered with Ni are dense but contain around 10 per cent M_2C_3. The carbides sintered without Ni are less dense but contain nearly no M_2C_3. For dense carbides, it is known that the existence of M_2C_3 is linked to the O and N contents of the carbides. For less dense carbides, M_2C_3 is eliminated through the reaction: $2M_2C_3 + MO - 5MC + CO$. CO can escape due to the presence of the porosities. The difference between the two types of carbides is due to the fact that the accelerated densification observed when Ni is used as a sintering aid does not allow CO to escape. (auth)

8268 (CONF-681020–(Vol.2), pp 687-96) CHARACTERIZATION OF SAMARIA AND NEODYMIA MICROSPHERES PREPARED BY THE SOL-GEL PROCESS. Ambrose, C. J. (McDonnell Astronautics Co., Richland, Wash. Donald W. Douglas Labs.).

Development of a radioisotope heat source for energy conversion devices initiated experimental work with promethium-147 oxide. Various techniques to produce spheres were investigated, and the sol-gel process was selected. The starting material is dissolved, precipitated, formed into a sol, gelled into a microsphere, and calcined at high temperatures. Stand-in elements for promethium were nonradioactive samarium and neodymium. Testing of the samaria and neodymia microspheres was limited to shrinkage, crush strength, time at temperature, firing cycles, and X-ray analysis. After removal of the microspheres from the alcohol drying solution, the neodymia and samaria microspheres shrink from 43 to 46% at about 1400°C, respectively. Crush-strength tests on the neodymia and samaria microspheres show a maximum of 2000 g at 1000°C and 3000 g at 1200°C, with a minimum of about 100 g at 800 and 900°C for neodymia and samaria, respectively. In most cases, shrinkage was complete after 3 minutes at temperature, using 500°C vacuum-outgassed microspheres as a starting base. Variations in calcining cycles did not appreciably affect any of the properties. X-ray analyses of microspheres fired at 100°C intervals up to 1500°C were made to determine the crystal structure. Below 500°C, an amorphous form was obtained; Nd_2O_3 was hexagonal from 800°C and up, while Sm_2O_3 was monoclinic above 1000°C. Using this technique radioactive ^{147}Pm microspheres can be systematically produced for fueling radioisotope heat sources. (auth)

8269 (CONF-681020–(Vol.2), pp 727-30) LOW-TEMPERATURE SYNTHESIS OF EUROPIUM AND YTTERBIUM INTERMETALLIC COMPOUNDS. Craven, W. E. (Aerospace Research Labs., Wright–Patterson AFB, Ohio); Ostertag, W. (Corning Glass Works, N. Y. Research and Development Labs.).

Compounds between specific rare earths (Eu, Yb) and semimetals (As, Sb) were synthesized in the molar ratio 1:1 by reacting the rare earths (in excess) with the semimetal iodides in liquid ammonia. Isolation of the intermetallic reaction products can readily be performed by filtration due to the fact that the intermetallic compounds are insoluble in liquid ammonia. Advantages of this technique are compound formation well below temperatures where other methods of preparation are complicated by the high vapor pressure of the rare earths and possible decomposition of peritectic intermetallics. Compositional difficulties arise from ammonolysis and from complex reaction kinetics. (auth)

8270 (ORNL–4326) CHEMICAL VAPOR DEPOSITION OF SILICON CARBIDE FROM SILICON TETRACHLORIDE–METHANE–HYDROGEN MIXTURES. Spruiell, J. E. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 32p. Dep. CFSTI.

The effect of deposition parameters on the characteristics of silicon carbide deposits produced by chemical vapor deposition from silicon tetrachloride-methane-hydrogen mixtures was studied. The deposits were characterized by determining deposit density and soundness, phases present, surface appearance, hardness, and deposition rate. The variables found to have the greatest effects on deposit characteristics were deposition temperature and inlet gas stream composition. The surface morphology of the deposits varied and the smoother deposits were associated with low deposition temperatures, fine-grained "laminar" microstructures, and the occurrence of free silicon. Although deposition temperature was most important, surface morphology was also a function of the inlet gas stream composition. The deposition rate was also a function of temperature and inlet gas stream composition. Typically, the deposition rate at 100 torr increased from about 5 to 10 mils/hr (thickness) at 1300°C to about 30 to 40 mils/hr at 1500°C. The hardnesses of the deposits were all very high even when the deposits contained as much as 65 vol % Si; the range was 1331 to 3855 dph (1 kg load) with higher hardnesses being associated with higher relative amounts of silicon carbide in the deposits. (auth)

8271 (ORNL–4370, pp 1-4) CRYSTAL PHYSICS. Clark, G. W. (Oak Ridge National Lab., Tenn.).

An internal centrifugal zone growth technique was used in studying the growth of crystals of UO_2, UO_2-ThO_2 solid solutions, and eutectic structures of the cermet UO_2-W. Mechanical and temperature-sensing changes, made on the system to produce crystals of higher perfection, are being evaluated. Molten-salt solvent techniques were used to grow single crystals of ThO_2, CeO_2, GeO_2, $ZrSiO_4$, $HfSiO_4$, and $ThSiO_4$, doped with transuranic and lanthanide ions for studies of thermoluminescence, optical absorption, and electron-spin resonance. Infrared spectra and optical perfection are being studied on hydrothermally grown quartz in various alkali hydroxide solvents. The Verneuil method was used to grow single crystals of magnetic ferrites for the proposed electromagnetic neutron-beam chopper. Crystals approaching the desired physical size and perfection were grown and methods for optimizing the neutron and magnetic properties within natural chemical constraints are being studied. The diamagnetic susceptibility of high purity ThO_2 crystals was determined to be -10.0×10^{-6} cm³/g. (auth)

8272 (ORNL–4370, pp 85-91) NITRIDE FUELS DEVELOPMENT. Scott, J. L.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Development of nitride fuels for space-nuclear and liquid-metal and fast breeder reactor applications continued. For LMFBR applications properly designed (U,Pu)N fuel pins can operate at significantly higher linear heat ratings and power densities than can mixed oxides. In addition, nitrides appear to have advantages over carbides in fabricability and compatibility with stainless steels and V-base alloys, both candidate cladding materials for the LMFBR. The development program includes fabrication, characterization, thermodynamic studies, compatibility studies, and irradiation testing. Processes were developed for fabricating a wide variety of sizes and shapes to meet the needs of the fundamental and applied studies, maintaining impurity levels below 500 ppM O and 200 ppM C. Processes were demonstrated for manufacture of single-phase UC_xN_{1-x} for any value of x desired. Apparatus for hot-pressing very high-density (U,Pu)N was designed, built, and tested, and capability was developed for characterizing (U,Pu)N by differential thermal analysis, thermogravimetric analysis, metallography, x-ray diffraction, and hot-stage microscopy. The kinetics of the conversion of UO_2 to UN was studied for sol-gel microspheres and powders and the feasibility of producing high quality (U,Pu)(C,N) from aqueous reprocessing feed was demonstrated. The limits of solubility of N and U in U(C,N) were determined and it was established that Vegard's law does not apply for UC-UN solid solutions. Thermodynamic analysis indicates that UN in solid solution with UC is more stable than expected from ideal-solution behavior. The thermodynamic stability of PuN proved to be comparable to that of UN. Vanadium and UN were found to be thermodynamically compatible. (auth)

8273 (ORNL–4370, pp 101-15) FUEL ELEMENT FABRICATION DEVELOPMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Samples containing enriched dispersions of UAl_3 and U_3O_8 were prepared and irradiated. A variety of comminuting techniques were tried to minimize the proportion of fines produced in preparation of UAl_3 powder fuels, with very little effect. The particle size distribution achieved was reproducible but depended on the

procedure used for making the measurement. The void volume in a dispersion-type fuel plate was shown to depend on both the type and concentration of the fuel; the highest void volume was achieved with burned U_3O_8. Basic fabrication studies are being conducted on processes for fabricating dispersion fuels. High-temperature compressive strength values of U_3O_8 and UAl_3 dispersion pellets were determined. As the volume fraction of the fuel is increased, the compressive strength of the UAl_3 pellets continuously increases, but that of oxide pellets reaches a maximum and then decreases. Especially at 5% plastic strain, large differences are found between the two. Uranium oxide powder was prepared in a flame reactor from UF_6, H_2, and O_2. The powder is readily sintered, after a treatment to remove excess F. It was demonstrated that PuO_2 powder could be made by chemical vapor deposition. Solid SiC deposits with a wide range in stoichiometry, giving hardness ranging from 1331 to 3855 DPH (1-kg load) were also deposited. To decrease corrosion of Al various anodizing techniques were tested. With high-purity Al, the only one that resulted in a decrease was an oxalic acid bath. The film characteristics depended on the bath temperature; lower temperatures appeared superior. The thickness of the corrosion film on a type 6061 Al specimen trippled when the specimen was held under strain. (auth)

8274 (ORNL–4370, pp 142–50) SOL-GEL FAST REACTOR FUELS. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

Assessment of sol-gel derived $(U,Pu)O_2$ fuel for fast reactors, particularly for the LMFBR's and the Fast Flux Test Facility, continued. Equipment for fabrication and characterization of Pu-bearing fuels was installed, the technique of packing microspheres of specified densities was established, the first sol-gel $(U,Pu)O_2$ pellets were prepared, analytical techniques for characterizing the fuel were developed, and equipment for measuring thermal conductivity of packed powders was devised. Irradiation tests to 4 at% burnup indicate that Sphere-Pac fuels will perform in the reactor comparably to pelletized fuels of similar smear density. Instrumented capsule irradiation tests were started to investigate the behavior of sol-gel derived mixed oxide fuels as a function of fuel temperature. The first capsule was designed and operated successfully. Tests were designed for off-normal conditions such as power transients and for testing in the EBR-II. Calculation methods required for irradiation testing and for analysis of the results were developed. (auth)

8275 (ORNL–4370, pp 161–4) ASSISTANCE IN RESEARCH REACTOR CORE PROCUREMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Technical assistance was furnished to the AEC in preparing specifications for fuel elements, in making technical audits of fuel manufacturers, and in discussions of the fabrication of dispersion fuel elements. Assistance was provided in procurement and inspection of fuel cores for AF-NETR and PM-4. It was found that even with ORNL fabricating procedures, much more dogboning was encountered with UAl_3 than with U_3O_8 and that the amount was a function of fuel concentration. It was demonstrated that arc melting of UAl_3 need not result in the presence of free U, but that considerable variation in structure and composition might be expected. Segregation of B_4C burnable poison results when finer than desired particles are exposed to moisture, which causes clumping; it may be avoided by vacuum drying. Electron-beam welding was shown to have potential as a positive technique for attaching fuel plates in research reactors. In attempts to compare relative sensitivities for measuring fuel homogeneity by x-ray attenuation and by scanning holographs, difficulty was encountered in obtaining standard curves with the accuracy previously obtained for the x-ray attenuation machine. Some, but not all, of the increase in spread was traced to machining errors. When standards are established for variation in fuel content, aperture size must be considered. The minimum visually detectable fuel increase in a high-quality radiograph of a dispersion plate is 7% for a spot diameter of 0.125 in. or 8% for an 0.078-in.^{2} area. (auth)

8276 (ORNL–4370, pp 165–74) GAS-COOLED REACTOR PROGRAM. Coobs, J. H. (Oak Ridge National Lab., Tenn.).

Progress is reported on bonding of coated-particle fuels, application of outer coating of pyrolytic carbon, computer prediction of coated particle irradiation behavior, neutron effects on carbon-coated ThO_2 microspheres, concrete pressure vessel development, and welding boilers. (J.R.D.)

8277 METALLIC CARBIDES AND A PROCESS OF PRODUCING THE SAME. Bourdeau, Romeo G. (to Union Carbide Corp.). U. S. Patent 3,399,980. Sept. 3, 1968. Filed Feb. 13, 1962.

The process for producing a metallic carbide is given in which a hydrocarbon gas inter-reacts with a metallic halide at 1500 to 3000°C and at a pressure of 1 to 200 mm of mercury. A metallic carbide of superior hardness is produced by reacting the vapors of tantalum, hafnium, niobium, titanium, silicon, zirconium, thorium, tungsten, molybdenum, or uranium chlorides with the gaseous hydrocarbon. The design of the equipment is given. (J.C.W.)

8278 URANIUM CARBIDE–PLUTONIUM PHOSPHIDE AS A REACTOR FUEL. (to United States Atomic Energy Commission). British Patent 1,137,239. Dec. 18, 1968. Priority date June 13, 1967, United States.

A nuclear reactor fuel containing a mixture of uranium carbide and plutonium phosphide, which can be made into a fuel element by compacting relatively coarse uranium carbide particles into a fuel element tube and filling the interstices between the uranium carbide particles with relatively fine plutonium phosphide by vibratory compaction to form a dispersion of uranium carbide in plutonium phosphide is described. (auth)

8279 NUCLEAR FUEL ELEMENT. Bailly, Henri; Francois, Bernard; Meny, Lucienne (to Commissariat a l'Energie Atomique). U. S. Patent 3,409,504. Nov. 5, 1968. Priority date Feb. 2, 1966, France.

A fuel element formed of a ceramic material having an actinide oxide base and contained in a can formed of zirconium or zirconium alloy with an intermediate layer formed of a metallic nitride, especially of titanium and/or niobium located between the base and the can is described. (auth)

8280 IMPROVEMENTS IN APPARATUS FOR THE MANUFACTURE OF URANIUM FLUORIDE. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). British Patent 1,137,494. Dec. 18, 1968. Priority date Jan. 12, 1965, France.

An apparatus for the production of UF_4 by reaction of HF gas with UO_2 is described. The apparatus consists of a furnace and a cooling zone. The HF and UO_2 flow counter-currently in the cooling zone. Cooling zone temperature is sufficiently lower than the furnace reaction temperature to ensure the absorption of residual HF gas. Means are provided for controlling HF gas flow and UO_2 flow to produce an optimum yield of UF_4. (F.S.)

8281 IMPROVED FUEL PELLET FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,135,366. Dec. 4, 1968. Priority date Nov. 18, 1966, United States.

An improved ceramic fuel pellet for rod type fuel elements is described. The pellet has longitudinal slots on the exterior and internal lateral surfaces to decrease the effect of pellet temperature on irradiation induced growth reducing compressive hoop stresses on the tabular cladding which encloses the pellet. (F.S.)

8282 OXIDE CONTAINING PRODUCTS AND PROCESS FOR MANUFACTURING THEM. (to Canadian Patents and Development Ltd.). British Patent 1,137,493. Dec. 18, 1968. Priority date Dec. 14, 1964, United States.

A process is described for manufacturing dense hard metal oxide products such as Fe_2O_3, BeO, UO_2, ThO_2 or cermets containing a metal and a metal oxide. The oxides are fabricated and densified using a decomposition reaction. Starting materials are carbonates, bicarbonates, sulfates, nitrates, hydroxides, or hydrated hydroxides which on decomposition yield an oxide or mixture of oxides. The starting material is formed in the required shape in a die and heated to a temperature to cause decomposition. Pressure is applied during the decomposition. (F.S.)

8283 SYNTHESIS OF THE DISELENIDES OF MOLYBDENUM, TUNGSTEN, AND NIOBIUM. Obolonchik, V. A.; Prokoshina, L. M. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1654–7(Oct. 1968). (In Russian).

On interaction of hydrogen selenide with Mo, W, or Nb in a wide temperature range, diselenides, MSe_2, are obtained, which are the most stable phases in the given systems. (tr-auth)

8284 PROCESS FOR PRODUCING DENSE PARTICLES OF OXIDES OF ACTINIDES USABLE AS FUELS FOR NUCLEAR REACTORS. Cogliati, Guido; De Leone, Ruggero; Mezi, Enzo; Scibona, Giancarlo; Lanz, Renato (to Comitato Nazionale per l'Energia Nucleare). U. S. Patent 3,401,122. Sept. 10, 1968. Priority date June 24, 1964, Italy.

Ceramic nuclear fuels are produced from a starting product consisting of a colloidal solution having a ratio nitrate to metals ranging from 0.5 to 1.8. The transformation of the colloidal solution into a gel is obtained by extracting the nitrates through anionic exchange with a liquid anionic exchanger contained in a water-immiscible solvent into which the colloidal solution is sprayed or dispersed which contains the actinides. The process is applicable both to thorium and to uranium and plutonium. (auth)

8285 THE PREPARATION OF CRYSTALLINE UO_2 BY THERMAL DECOMPOSITION OF $UOCl_2$ DISSOLVED IN MOLTEN UCl_4. Schlechter, M. (European Institut fuer Transuranium Elements, Karlsruhe, Ger.). J. Nucl. Mater., 28: 228-9(Nov. 1968).

Experiments are described in which UO_2 crystals are produced. A starting mixture of UO_2–UCl_4 is heated to 1000°C. Well-formed UO_2 crystals about 0.2 mm in size were produced. On subsequent cooling to 775°C, UO_2 crystals of about 1 mm in size were produced. (J.C.W.)

8286 METHOD FOR PRODUCING A MULTI-CONSTITUENT NUCLEAR FUEL. Nishimura, Yaichi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-18518. Aug. 8, 1968. Filed Aug. 8, 1965.

A proposed method for producing fuel is described in which porous (preliminarily-) sintered nuclear-fuel ceramic material, with the void ratio 35 to 60%, obtained by powder metallurgy, is soaked with uranium, thorium, or plutonium, or two or three of them. The whole is then dried and sintered. (NSA of Japan)

8287 VIBRATORY COMPACTION METHOD FOR THE FABRICATION OF CERAMIC NUCLEAR FUEL ELEMENTS. Hirose, Yasuo; Takeda, Seiji (to Hitachi, Ltd.). U. S. Patent 3,413,383. Nov. 26, 1968. Priority date Oct. 28, 1964, Japan.

A method for solidifying ceramic nuclear fuel powders comprises introducing the powder into a metal cladding tube, compacting said powder by reducing the pressure in the cladding tube and heating the powder to a temperature less than its sintering temperature, e.g., less than about 300°C., while concurrently vibrating said powder until a maximum packed density is achieved and further heating the cladding tube to a temperature sufficient to solidify the packed ceramic nuclear fuel powder, e.g., higher than about 300°C., but not so high as to be detrimental to the cladding tube. (auth)

8288 FABRICATION OF STABILIZED URANIUM MONOCARBIDE COMPACTS. Maruya, Kazuo; Takahashi, Shuichiro (Mitsubishi Atomic Power Industry, Inc., Saitama, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 605-13(Dec. 1968).

Hyperstoichiometric UC powder was prepared by carbothermic reduction, and a study was made of compaction by high pressure impaction. Ten different additives were tried for their properties of stabilizing the composition of UC. The results can be summarized as follows: Very dense UC compacts (97% T.D.) were obtained by high pressure impaction forming (at 1,200°C, 30 kbar), and these densities could be further improved slightly by heating at 1,550°C. The effect of additive elements was examined by x-ray diffraction and metallography. All the additives examined were found effective in decarburizing UC_2 to UC, and the added elements were found to form carbides by vacuum heating. Three of the elements tried, V, Cr, and Ti, were judged most suitable for possible use as stabilizing agents in consideration of the expected conditions to which UC would be subjected in actual use as fast breeder reactor fuel. The addition of W and Mo would be also available for high temperature application. (auth)

8289 PREPARATION OF URANIUM NITRIDES FROM URANIUM TETRAFLUORIDE. Yoshihara, Kazuhiro; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 643-7(Dec. 1968).

A method has been developed for preparing UN by two-step reaction using UF_4. As a result, the reaction of UF_4 with Si and N_2 has proved practical for obtaining U_2N_3. It was confirmed by chemical analysis and by x-ray diffraction analysis that single phase U_2N_3 was obtained at reaction temperatures above 1,200°C, and only 3% of the uranium was lost by evaporation even at 1,200°C. In the second reaction, the dissociation of U_2N_3 to UN in vacuum took place rapidly above 1,050°C, at which temperatures single phase UN was obtained, possessing a lattice constant of 4.888 Å. (auth)

8290 METHOD OF FABRICATING LOW PERMEABILITY NUCLEAR FUEL BODIES. Tully, Geoffrey R. Jr.; Goeddel, Walter V. (to Gulf General Atomic Inc.). U. S. Patent 3,406,227. Oct. 15, 1968. Filed Oct. 19, 1962.

A method of preparing a solid, high temperature nuclear fuel with reduced gas permeability is described. Individual solid nuclear fuel particles enclosed in a protective jacket of pyrolytic carbon are dispersed in a matrix of finely divided graphite and compacted into a solid fuel body. The fuel body is treated to reduce gas permeability by impregnating the pores of the body with a polymerizable substance followed by curing and carbonizing. The body is then heat treated. The fuel body retains fission gases. (F.S.)

8291 INVESTIGATION OF MOLYBDENUM SILICONIZING IN A GLOW DISCHARGE. Prokoshkin, D. A.; Arzamasov, B. N.; Ryabchenko, E. V. pp 276-80 of Svoystva i Primeneniye Zharoprochnykh Splavov. Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The schematic and operation of a unit for siliconizing metals with glow-discharge heating are described. Experiments were made on pure molybdenum wire, 0.3 mm in diameter, in a mixture of silicon tetrachloride vapor and dry commercial-grade hydrogen. The design of the unit also permitted electric resistance heating of the wire. The partial pressures of silicon tetrachloride vapor and hydrogen were 30 and 10 mm Hg respectively. The temperature of siliconizing with glow-discharge heating was 1100°C and with resistance heating—1300°C. In both cases, heating the wire to the siliconizing temperature lasted 0.5 min, the holding time at this temperature was 5 min, and the time of cooling to 200°C was about 1 min. Regardless of the method of heating, no molybdenum siliconizing was observed in the absence of hydrogen in the ambient medium, but a silicide coating was readily formed on the wire surface when a mixture of silicon tetrachloride vapor and hydrogen was used. The weight and size of the test specimens also increased. The silicide coating consisted of an outer $MoSi_2$ phase, an inner Mo_3Si phase, and a thin layer, probably of the Mo_5Si_3 phase, between them. In siliconizing with glow-discharge heating, the silicon impregnation proceeded much more rapidly than with other methods, particularly at lower temperatures. Thus, siliconizing at 800°C with glow-discharge heating and at 1200°C with resistance heating produced silicide coatings of the same thickness. Regardless of the method of heating, the reaction products were the same as was also the oxidation resistance of the formed coatings, continuously or cyclically heated in air at 1500°C. The maximum number of heating cycles sustained by coatings 40-μ thick was 330. Tungsten, niobium, tantalum and a number of other metals were also successfully siliconized with glow-discharge heating. (ATD)

8292 HIGH-TEMPERATURE FUEL WORK AT SEIBERSDORF. Bildstein, H. (Reaktorzentrum, Seibersdorf, Austria. Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). Met. Soc. Conf., 42: 145-63(1966).

Development of economic processes for the preparation of kernels of fissile and fertile material and development and construction of coating facilities to produce high-quality pyrocarbon coatings in high-capacity units are described. The main achievement in particle coating was the development of a coating apparatus with porous metal or graphite plates in the bottom, which permitted an enlargement of the bed capacity to more than 5 kg. The influence of impurities on the quality of the coating has been studied. Besides carbon, silicon carbide, and boron carbide (for control materials) layers are deposited. The substrate for B_4C control material is carbon in the form of graphitized spheres of 300-micron diameter. The development of fabrication procedures is supported by a program of testing and evaluation of HTGR fuel. Pre-irradiation testing includes chemical, physical, and metallographic examination. Irradiation tests of loose particles in static or swept graphite capsules in the ASTRA-reactor and post-irradiation examinations are also performed. Head-end processes are being developed that include methods for the disintegration of fuel compacts, separation of irradiated particles, and recovery after a suitable thermal or chemical treatment. (auth)

8293 COATED PARTICLE FUEL ELEMENTS FOR UHTREX. Bard, R. J.; Taub, J. M. (Los Alamos Scientific Lab., N. Mex.). Met. Soc. Conf., 42: 105-18(1966).

The Ultra High Temperature Reactor Experiment (UHTREX) of the Los Alamos Scientific Laboratory utilizes a helium-cooled, graphite-moderated reactor to be operated at a thermal power of 3 MW. Fuel elements are required for the startup and early operation that will permit checkout of this high-temperature (2400°F), high-pressure (500 psi) reactor and evaluation of its operational characteristics with minimum contamination of the entire reactor system. The coated fuel particles and other ingredients are described and details of the equipment and procedures used for UHTREX fuel element fabrication are presented. Properties of the fuel elements are reported. (auth)

8294 FUELED-GRAPHITE ELEMENTS FOR THE GERMAN PEBBLE-BED REACTOR (AVR). Burkett, M. N.; Eatherly, W. P. (Union Carbide Corp., Lawrenceburg, Tenn.); Harms, W. O. Met. Soc. Conf., 42: 45-64(1966).

The development, fabrication, testing, and evaluation of spherical graphite fuel elements for the first core loading of the German Pebble-Bed Reactor (AVR) are described. The AVR is a high-temperature, helium-cooled system designed to operate at 46 MW(t) with mixed mean exit temperature of 850°C and maximum fuel surface temperature of approximately 1050°C. The core loading contains thirty thousand 6-cm-dia graphite spheres, each with 6 grams of heavy metal as duplex, pyrolytic-carbon-coated $(Th,U)C_2$ particles. These fuel elements are the first nonpurged elements manufactured for a high-temperature gas-cooled reac-

tor. The spherical particles were prepared by a plasma melting technique and were coated with two structurally different layers of pyrolytic carbon in fluidized bed coaters. The fuel element was fabricated by injection molding a graphite matrix containing the coated particles into a 1-cm-thick machined ATJ graphite shell. The major requirements for these elements include fission-product retention, dimensional stability, and resistance to impact, abrasion, and oxidation. A description is given of the development of test criteria and the production quality assurance procedures used in meeting these requirements. Almost one-half the cost of the fuel elements was due to the quality assurance requirements which were understandably very stringent for this initial loading. Considerations for reducing costs of elements for future loadings are discussed. Details are presented regarding the irradiation proof tests and the fission-product-release guarantees for both loose coated particles and fuel elements. (auth)

8295 DEVELOPMENT OF BERYLLIA-BASED DISPERSION FUELS FOR THE AUSTRALIAN HTGC PEBBLE-BED REACTOR STUDY. Smith, R. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). Met. Soc. Conf., 42: 439-64(1966).

The status of materials research on the spherical, beryllia-based, dispersion-type fuel elements for a 200 MWe pebble-bed reactor is reported. An account is given of the reactor concept and the main design parameters, the flow sheets for fabricating and reprocessing fuel elements, and the results of the study of the main materials problems, including the physical and mechanical behavior of oxide dispersions, thermal-stress failure, the effects of irradiation-growth stresses and contact stresses, irradiation performance, and fission product release. It is concluded that the fuel could have adequate performance to meet the technical requirements in the high-temperature pebble-bed reactor environment, but that application in central power stations appears unlikely because of doubtful economic prospects. (auth)

8296 PREPARATION OF ALUMINA AND ZIRCONIA COATED NUCLEAR FUEL PARTICLES. Amato, Ignazio (FIAT, Turin). Rev. Int. Hautes Temp. Refract., 5: 167-71(July-Sept. 1968).

Uranium dioxide fuel particles of 100 to 150 μ diameter spheroids coated with Al_2O_3 or ZrO_2 are proposed for use in advanced nuclear reactors. The UO_2 particles are coated by deposition of the Al_2O_3 or ZrO_2 in a fluidized bed with the metal oxide obtained from decomposition of the halide. A decomposition of 80 wt % of the halide is obtained by operating at $AlCl_3$ evaporation rates of 30 g/hr and $ZrCl_4$ evaporation rates of 15 g/hr with an R_{H_2O} factor of more than 10 and a decomposition temperature of 1300°C. (auth)

8297 A PROCESS FOR THE PRODUCTION OF SPHERICAL GRAPHITE FUEL ELEMENTS. (to Nukem Nuklear-Chemie Und-Metallurgie Gesellschaft mbH). British Patent 1,137,939. Dec. 27, 1968. Priority date Dec. 18, 1965, Germany.

A process is described for forming spherical graphite fuel particles for gas-cooled high-temperature reactors. Fuel particles containing carbon black and graphite are pressed by dies into a rubber mold having an ellipsoidal cavity. The mixture deaerates during pressing. (F.S.)

Properties Evaluations

Refer also to abstracts 8133, 8134, 8148, 8169, 8265, 8267, 8272, 8274, 8322, 8335, 8337, 8338, 8349, 9154, 9237, and 9242.

8298 (CONF-681020-(Vol.1), pp 163-73) THE THERMODYNAMIC BEHAVIOR OF A WIDELY NONSTOICHIOMETRIC REGION OF THE PRASEODYMIUM OXIDE SYSTEM. Jenkins, Michael S.; Eyring, LeRoy (Arizona Univ., Tempe. Dept. of Chemistry).

A thermogravimetric isobaric technique was used to derive partial molar thermodynamic quantities for the solution of oxygen in the alpha region of praseodymium oxide in the temperature range 400 to 800°C and at various constant pressures from 170 to 700 torr. Under these conditions, the alpha region is single phased and disordered, having a composition range $1.830 \geq O/M \geq 1.785$. Three discrete families of curves were obtained in the free energy plot giving three values for $\Delta\bar{S}$ and $\Delta\bar{H}$, two of which are markedly different. Detailed analysis of the thermodynamic data shows the alpha surface to have fine structure. The derived thermodynamic quantities are compared with those of related systems and are shown to fit a general scheme describing the defect behavior of fluorite type oxides. (auth)

8299 (CONF-681020-(Vol.2), pp 521-8) COMPOUNDS OF RARE EARTH METALS WITH ELEMENTS OF NITROGEN SUBGROUP. Mironov, K. E. (Akademiya Nauk SSSR, Novosibirsk. Institut Neorganicheskoi Khimii).

A study of double rare earth compounds with nitrogen subgroup elements, pnictides, is connected with a search for new refractory materials of interest by their electrical, magnetic, and other properties. The synthesis of pnictides is carried out directly from elements or indirectly from elements or indirectly through their compounds. The preparation of the single crystals of refractory compounds is possible through gas-phase reactions including the use of some substances as transporters. The single crystals of lower-melting compounds (antimonides, bismuthides) are grown from a melt by a directed fractional crystallization. Some of the data received were compared with data known for actinide compounds. Characteristics of monopnictides of rare earth metals and possible fields of their practical application are given. (auth)

8300 (CONF-681020-(Vol.2), pp 821-32) ELECTRONIC LEVELS AND THERMODYNAMIC PROPERTIES OF CERIUM(III), THULIUM(III), AND LUTETIUM(III) OXIDES. Westrum, Edgar F. Jr.; Justice, Bruce H. (Michigan Univ., Ann Arbor. Dept. of Chemistry).

From adiabatic heat capacity measurements over the range 6 to 350°K on Ce_2O_3, Tm_2O_3, and Lu_2O_3 the thermal properties were evaluated. Lower-lying crystal-field electronic energy levels of the $^3H_6$ ground term of the Tm(III) ion were deduced from these data and previous measurements. The observed electronic heat capacity of the Tm(III) ion is well fit by the levels for the C_2 ions reported by Gruber, et al., together with the following levels for the C_{3i} ions: 600/cm triplet, 1050/cm doublet, and the seven remaining levels near 2500/cm. The adjustment of the Ce_2O_3 data for excess oxygen and the interpretation of the energy levels is also considered. (auth)

8301 (EUR-3614) SEARCH FOR A CERAMIC CRUCIBLE MATERIAL FOR URANIUM SMELTING. Lanaspeze, P.; Tannenberger, H. (Battelle Memorial Inst., Geneva (Switzerland)). July 10, 1968. Contract 003-65-6 RCIS. 96p. (In French). Dep.

A ceramic material was sought which was to be as inert as possible with respect to molten uranium. From a possible combination of those ceramics which are thermodynamically most stable, a first choice based on oxides was made and eight solid solutions or combinations arising from the following five oxides were examined: BeO, CaO, SrO, UO_2 and La_2O_3. In addition to the behavior of these materials in contact with molten uranium, the methods of preparation and physical properties were examined. Following this second screening, which was necessary because of the novelty of the materials, the only combinations left were those of the system $BeO-La_2O_3$. Materials based on this system showed a reduced contamination tendency compared with sintered beryllium oxide. However, the softening points were about 1200°C (owing to peritectic reactions in the equilibrium diagram). Ceramic materials were prepared from single conventional refractory oxides bound by $BeO-La_2O_3$. Their properties are briefly outlined. (auth)

8302 (EURFNR-528) MECHANICAL PROPERTIES OF UO_2. Engelhardt, G.; Hoffmann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-729. 54p. (EUR-3729). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Several studies have been made of the main UO_2 elastic and plastic properties. However, the dependence of characteristics on externally and structurally determined parameters has only been worked through partially and unsystematically. In general, UO_2 does not have unusual mechanical properties for an oxide ceramic material. The controlling lattice physics phenomena are noticeably influenced by grain size, porosity, and extraneous ions. In the elastic property studies, this influence was registered phenomenologically; there is no basis for an atomistic understanding of the dependences found. (auth)

8303 (LA-DC-10046) THE LASL ^{238}Pu FUEL DEVELOPMENT PROGRAM (SEPO/SNS/AEC). (Los Alamos Scientific Lab., N. Mex.). Oct. 1968. Contract W-7405-eng-36. 48p. (CONF-681022-1). Dep. CFSTI.

From Plutonium-238 Isotopic Fuels and Heat Source Program Review Conference, Washington, D. C.

A definition of solid solution fuel is given. A reference fuel composition of calcium oxide stabilized PuO_2-ZrO_2, at a Pu concentration corresponding to a power density of 1.7 watts/cc has been fabricated in pellets, with and without axial holes. Other specimens were fabricated into thin wafers, and large discs in two sizes. Compositions equivalent to 3.5 and 4.4 watts/cc have been fabricated. Properties presented on the PuO_2-ZrO_2 fuel

are crystallography, microstructure, chemical composition, density, thermal properties, and compatibility. Plutonium-238 specimens are also being tested for helium migration, thermal diffusivity, and sea water solubility. Calculated and estimated properties on thermal conductivity for PuO_2-ZrO_2 and PuO_2-ThO_2 fuels are summarized. Specimens are listed which are to be safety tested. (J.C.W.)

8304 (ORNL-4370, pp 26-9) FUNDAMENTAL CERAMICS RESEARCH. Fulkerson, W. (Oak Ridge National Lab., Tenn.).

UN, a potentially important fast-reactor fuel, was selected as a basis material for coordinating efforts of various groups engaged in basic ceramics research. Preliminary band structure calculations have been made and a number of property measurements are completed or well under way, including low-temperature specific heat (1.3 to 4.7°K), thermal conductivity (77 to 400°K), Seebeck coefficient (6 to 400°K), electrical resistivity (4.2 to 400°K), velocity of sound (300°K), self-diffusion of ^{233}U (1400 to 2100°K), and compressive creep (1400 to 1800°K). (auth)

8305 (ORNL-4370, pp 200-11) MOLTEN-SALT REACTOR PROGRAM. Weir, J. R. Jr.; McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.).

Activities in the MSRE materials surveillance program are summarized. Progress on materials development for MSBR is also described. (J.R.D.)

8306 (ORNL-4370, pp 221-9) THORIUM UTILIZATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

A program to use Th as a source of energy by converting it to fissionable ^{233}U comprises development of economical fuels, characterization of the physical and chemical nature of such fuels, and demonstration of the technical and economic feasibility of recycling such fuels. This includes testing of the fuels under irradiation and the development of processes for refabrication of fuel elements that are prototypic of designs useful for power reactors. The Th-U Recycle Facility was completed. The facility permits development and evaluation of a variety of integrated fuel processing and refabrication schemes at pilot-scale levels. A pneumatic system to transfer pyrolitic-carbon-coated particles between steps in the fuel fabrication process was completed. The 5-in. engineering-scale particle coating furnace achieved routine operation and a prototype remotely operated coating system was built. Several batches of special particles containing high-activity isotopes such as ^{233}U and ^{239}Pu were coated. The TURF was received from the contractor, placed in operation, and used to prepare ^{233}U-bearing fuel for the Molten Salt Reactor Experiment. (auth)

8307 (ORNL-TM-2355) EFFECT OF WORKING DIRECTION ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF AN EXTRUDED SAP ALLOY. Nilsson, T. M. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Bars of commercial SAP 895-Sintered Aluminum Product containing about 10.5 wt % Al_2O_3-were further worked transverse and parallel to the initial extrusion direction. The original extrusion ratio was about 20. The as-extruded structure was very sensitive to transverse working and only extrusion and swaging at high temperature were accomplished in that direction without difficulty. Tensile properties were determined at 450°C in the new working direction. After small amounts of transverse working, properties were low due to the unfavorably aligned structure. At higher reductions the structure became realigned into the new working direction and both strength and ductility exceeded significantly the as-extruded values. Especially noteworthy was the more than doubled uniform elongation after transverse swaging 30:1; this improvement seemed to stem from the complicated way the oxide particles became aligned during transverse swaging. Further longitudinal extrusion generally increased mechanical properties slightly. The increases in strength were smaller than would be expected from the marked improvements in the dispersion of the oxide phase due to secondary working. (auth)

8308 UNSTABLE CERMET COMBINATION OF U_3O_8 AND ALUMINIUM. I. THE TECHNOLOGY OF U_3O_8-Al CERMETS. Ondracek, G.; Schulz, B. (Institut fuer Material- und Festkoerperforschung, Karslruhe, Ger.). Ber. Deut. Keram. Ges., 45: 509-13(Oct. 1968). (In German).

Compacting of U_3O_8-Al cermets is performed. Experimental measurements are compared with those reported previously. The component powders are first characterized. The mixing method of sedimentation adjustment and experiments on determining the degree of dispersion are described. The shaping methods discussed include cold pressing, sintering, rolling, extrusion and picture-frame technique. The factors influencing density are discussed. (tr-auth)

8309 PRECIPITATED CARBIDES IN ALLOY SYSTEMS. PART I AND PART II. Marcantonio, J.; Newkirk, J. B. (Univ. of Denver). Electrochem. Technol., 6: 447-61(Nov.-Dec. 1968).

The facts about precipitated carbide compositions have been summarized. Crystallographic and thermodynamic data have been tabulated. Carbide phases found as minor phases in alloy systems and common carbides which occur as precipitates in alloys are described. Metal carbide systems discussed are aluminum carbides, chromium carbides, molybdenum carbides, niobium carbides, tantalum carbides, and titanium carbides. A listing of 111 references is included. (J.C.W.)

8310 DIFFUSION IN POLYCRYSTALLINE Y_2O_3 AND Er_2O_3. Berard, Michael Frank. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 106p. (IS-T-230).

Thesis.

A study of self-diffusion in Y_2O_3 and Er_2O_3 is presented. A tracer sectioning technique was employed to measure cation self-diffusion coefficients in fully dense polycrystalline materials under oxidizing conditions. The results are described by the relations $D = 1.65 \times 10^{-2}$ exp (-69,200/RT) cm^2/sec for Y_2O_3 (1400 - 1670°C), and $D = 1.48$ exp (-102,200/RT) cm^2/sec for Er_2O_3 (1400 to 1700°C). The greater activation energy for erbium diffusion in erbia is attributed to a mass effect. Oxygen diffusion coefficients were extracted from observations in the reoxidation of small single crystals of uniformly reduced oxides produced by vacuum fusion. The oxidation process was demonstrated to proceed by the development of a fully oxidized external shell, the growth of which was rate-limited by diffusion of interstitially dissolved oxygen through the oxidized layer to a sharp interface with the reduced material. The growth of the oxidized shell was followed by means of a thermobalance. Using standard techniques for treatment of diffusion in the presence of a moving boundary, and estimating the saturation limit for interstitial solution of oxygen in the known crystal structure, oxygen diffusion coefficients were calculated. These results are described by $D = 6.01 \times 10^{-6}$ exp (-19,600/RT) cm^2/sec for Y_2O_3 (1064 to 2376°C), and by $D = 4.76 \times 10^{-5}$ exp (-30,100/RT)cm^2/sec for Er_2O_3 (1060 to 1292°C). (Disser. Abstr.)

8311 TEMPERATURE DEPENDENCE OF ELECTRO-PHYSICAL PROPERTIES OF CERIUM HEXABORIDE WITH TRANSITION METALS. [PART] II. Bondarenko, V. P.; Kovenskaya, B. A. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 97-100(1968). (In Russian).

Temperature dependence of electric resistance of thermal emf of cerium hexaboride alloys with Hf, Ta, W, and Re was studied using specimens hot-pressed in graphite presses at 2150°C. It was found that the thermal resistance coefficient of the solid solutions of metals in the cerium hexaborides is determined by the properties of the dissolved metals. The weakening of the interatomic bond in the series of solutions of CeB_6 + 0.5% W, CeB_6 + 0.5% Re, CeB_6 + 0.5 Ta, and CeB_6 + 0.5 Hf was observed and confirmed using the data on thermal emf of the studied alloys. (R.V.J.)

8312 INVESTIGATION OF THE HOT HARDNESS OF ZIRCONIUM CARBIDE. Evstyukhin, N. A.; Shchavelin, V. M. Met. Metalloved. Chist. Metall., Sb. Nauch. Rabot, No. 6, 101-7(1967). (In Russian).

Results are presented of an investigation of the hot hardness of sintered specimens of ZrC of a composition close to that of a monocarbide. Two test methods were employed: the static method, based on the UST-2 test rig (cf. Yu. G. Godin, et al., V. sb. "Metallurgiya i metallovedeniye chistykh metallov." Vyp. 5, M., Atomizdat, 1966, str. 189) and the dynamic method (according to the extent of the rebound of the spherical indentor), at 900 to 1650 and 2500°C, respectively. The dynamic tests show that the hardness of specimens of ZrC markedly decreases with increase in temperature. At room temperature, ZrC is a brittle relatively nonplastic material, but beginning at 1500 to 1600°C, it undergoes considerable softening (plasticizing). The static tests, on the other hand, indicate that loss of hardness commences at lower temperatures (1000 to 1200°C); the reason for this discrepancy may have been that the specimens used in the static tests contained less carbon, i.e., the content of this component in the alloy did not correspond to its stoichiometric composition. Thus, e.g., as the C content decreases (compared with its stoichiometric content), hot hardness sharply decreases (roughly in half when the temperature rises to 1270 from 930°C). (ATD)

8313 BEHAVIOR OF BISMUTH BONDING BETWEEN POWDER COMPACTED CERAMIC FUEL AND CLADDING. Kubota, Tadashi; Takahashi, Shuichiro; Honda, Yutaka; Komine, Isao; Odajima, Takeo (Mitsubishi Atomic Power Ind., Inc., Japan). Nippon Genshiryoku Gakkaishi, 10: 678-83(1968). (In Japanese).

Evaluation by out-of-pile heating experiment was made on two types of bismuth heat transfer bonding between powder compacted ceramic fuel and cladding. The first was a vibration compaction of a mixture of ceramic fuel powder and bismuth powder in a cladding tube, and the other was a vibration compaction of ceramic fuel powder in a cladding tube with bismuth lamella formed on the inner surface of the cladding. The results were as follows: In the first case of mixed UO_2 and distributed in the central region of the compact (2,600 ~ 2,700°C) evaporated and moved toward the periphery (800 ~ 900°C) where it assembled to serve as a good liquid heat transfer medium. In the second case, the bismuth lamella served as a good liquid heat transfer medium without permeating into the inner regions of the compact. There was no appreciable reaction between the bismuth and UO_2 up to 2,600 ~ 2,700°C, nor between the bismuth and UN or UC up to 1,200 ~ 1,300°C. (auth)

8314 GRAPHITE: ADVANTAGES, LIMITATIONS, AND APPLICATIONS. Nightingale, R. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Met. Soc. Conf., 42: 11-28(1966).

Reactors now being constructed or planned will also use graphite or carbon for fuel sleeves, fuel-particle coating, fuel matrix, thermal insulator, neutron shield, or control-rod material. In some cases the temperatures will be very high, over 2000°C, and the fast-neutron dose greater than 10^{22} nvt. Dimensional stability at these very high doses is not well known, especially at the high temperatures contemplated in future reactors, and the complexity of the damaging processes makes predictions very difficult. Under some conditions, radiation-induced creep will occur fast enough to relieve the stresses generated internally or produced by external loads and restraints. However, the range of acceptable operating conditions for a given graphite is yet to be determined. Rapid progress in the development of pyrolytically coated fuel particles has made it possible to abandon restrictive requirements on permeability of the graphite fuel tubes in the high-temperature gas-cooled reactors. More work seems desirable for the economic manufacture of large, crack-free, isotropic graphites needed for good dimensional stability and for bodies with a thermal-expansion coefficient suitable for coatings. (auth)

8315 CHEMICAL AND THERMAL STABILITY OF A BeO-BASE FUEL SYSTEM IN AN OXIDIZING ENVIRONMENT. Aitken, E. A. (General Electric Co., Pleasanton, Calif.); Brassfield, H. C.; Turner, P. P. Contract AT(40-1)-2847. Met. Soc. Conf., 42: 421-37(1966).

A high-temperature BeO-base fuel system that is essentially thermodynamically stable in any oxidizing gaseous environment, is described. The fuel is a solid solution of UO_2 and Y_2O_3 dispersed in the BeO. The oxidation rate of >98% dense BeO–UO_2–Y_2O_3 composites with <12 vol % of 5-μ fuel particles was controlled by oxygen diffusion in the BeO matrix. At 25 vol % fuel phase, the oxidation rate was similar to that of the fuel phase alone. The effects of continuity of fuel phase, location of fuel (inter- or intra-granular), and surface-to-volume ratio of the composite, on the oxidation rate of the composites are shown. The fuel loss from the BeO composites was controlled by diffusion in some cases and possibly by volatilization in others. The loss of fuel located within the BeO grains was insignificant at temperatures as high as 1700°C. (auth)

8316 PHYSICO-CHEMICAL PROPERTIES OF CARBIDE FUEL FOR THERMIONICS. Yang, L.; Hudson, R. G.; Carpenter, F. D. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Met. Soc. Conf., 42: 481-99(1966).

Studies pertinent to thermionic applications have been made on physico-chemical properties of uranium zirconium monocarbide such as langmuir rates of vaporization of UC–ZrC as a function of composition and density in the range 1700 to 2000°C, compatibility of UC–ZrC with refractory metals at 1400 to 2000°C, and electron emission properties of tungsten-clad UC–ZrC at 1400 to 2000°C in vacuum for 1000 hours. The results indicate that tungsten-clad UC–ZrC fuels are promising materials for thermionic applications. (auth)

8317 URANIUM OXIDE FUEL FOR THERMIONIC ENERGY CONVERSION. Grossman, L. N. (General Electric Co., Pleasanton, Calif.). Contract AT(04-3)-189. Met. Soc. Conf., 42: 501-15(1966).

Problems affecting thermionic reactor operation have been examined out-of-pile. Oxygen loss from metal-clad, hyperstoichiometric urania, urania evaporation into a cesium cover gas, and effects of thermal cycling on compatibility have been evaluated. Hyperstoichiometric urania will lose oxygen as $UO_2(g)$ when free evaporation is allowed. When tightly clad in tungsten, small amounts of excess oxygen in the urania will leave the tungsten as O(g). When sufficient excess oxygen is present (O-to-U ratios greater than about 2.01), gaseous tungsten (or molybdenum) oxides will leave the cladding surface. Stoichiometric urania evaporates principally as $UO_2(g)$. Stoichiometric urania clad in W loses oxygen at high temperatures by diffusion through the cladding and evaporation of O(g). The evaporation of urania at 1700 and 1900°C into a semi-infinite volume is suppressed by a factor of about 100 by cesium gas at 4 torr. The evaporation rate of urania also has been observed to be suppressed by an argon cover gas at 10 torr (10 torr argon is equivalent to 4 torr Cs on a simple diffusion model) at 1750°C with a cold collector 0.050 inch removed. The dependence of the suppression factor on gas pressure and on distance to a condensing surface is being evaluated for pressures and distances of thermionic interest. Suppression of evaporation of molybdenum at 1700°C by 4 torr Cs has also been observed. Thermal cycling of stoichiometric UO_2 between 1600 and 2200°C (for tungsten), and 1450 and 1750°C (for molybdenum) has revealed a small enhancement of uranium flux through the cladding after cycling. The observed U flux through W and Mo is typically about 10^{-10} g-h^{-1}-cm^{-2}, with peaks of 10^{-9} to 10^{-8} g-h^{-1}-cm^{-2}. (auth)

8318 OXIDATION OF UO_2 PELLETS IN AIR. EFFECT OF HEAT-TREATMENT OF PELLET ON PARTICLE SIZE DISTRIBUTION OF POWDERS PRODUCED. Iwasaki, Matae; Sakurai, Tsutomu; Ishikawa, Niro; Kobayashi, Yasuko (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 652-3(Dec. 1968).

The effects of heat treatments of UO_2 pellets at 1840 to 2080°C on the particle size of the resulting powder were studied. The treatments were made in vacuum at temperatures above the sintering temperature of the original pellets. Grain growth and weight decreases were observed in the heat treated pellets. Mean particle size of the powder and the range of size distribution increase with the sintering temperature. Particle size tended to increase with oxidation temperature. Size distributed is not affected by heat treatment. Initial and terminal procedures have little effect on size distribution. (F.S.)

Structure and Phase Studies

Refer also to abstracts 7505, 8159, 8266, 8267, 8270–8272, 8307, and 8338.

8319 (CONF-681020-(Vol.1), pp 295-307) CRYSTAL STRUCTURE OF $Eu_4Al_2O_9$. Brandle, C. D.; Steinfink, H. (Texas Univ., Austin. Dept. of Chemical Engineering).

The phase $2RE_2O_3 \cdot Al_2O_3$ occurs in rare earth aluminates for the series Sm–Lu. All compounds are isostructural and $Eu_4Al_2O_9$ was selected for detailed structural analysis. The compound is monoclinic, a = 7.604 Å, b = 10.628 Å, c = 11.105 Å, β = 108.50°, space group $P2_1/c$, and 4 formula weights in the unit cell with a calculated ρ = 6.29 g/cc. The integrated intensities of 3184 independent reflections were measured using a scintillation counter and monochromatic MoK_α radiation. The structure was refined by least-squares calculations with isotropic temperature factors to a conventional R factor of 0.053. The Al^{3+} is in tetrahedral coordination and Al–O bond distances are approximately 1.73 Å as expected for tetrahedral aluminum. The Eu are in sixfold and sevenfold coordination. The sixfold coordinated ion has O^{-2} at about 2.35 Å at the corners of a distorted octahedron; the sevenfold ion has 5 bonds at 2.35 Å and two at about 2.5 Å. The articulation of the polyhedra forms a cavity in the structure. The summation of ionic bond strengths shows that one oxygen has a local cation surrounding, which neutralizes its negative charge, one oxygen has a local positive imbalance and the other one an equal negative imbalance. The structure is unique to this stoichiometry of rare earth aluminates and gallates. (auth)

8320 (CONF-681020-(Vol.1), pp 309-22) COMPLEX RARE EARTH METAL CARBIDES AND NITRIDES. Nowotny, Hans (Vienna Univ. (Austria)).

Starting from a survey on complex carbides within ternary systems of type: T(transition element) – M(b-element of the Periodic Table) – X(nonmetal) the general structural element and particularly the perovskite carbide structure are discussed. A large number of carbides of formula $(R.E.)_3MC$ as well as some Nd-containing nitrides crystallizing with this type were detected (M stands for Al, Ga, In, Sn, and Pb). Some of these carbides are formed by gradual-filling of the metallic parent lattice, $(R.E.)_3M$, having Cu_3Au-type structure by carbon. An almost linear dependency of the lattice parameters with the trivalent rare earth ion radii can be observed exempt for the Ga-containing perovskite carbides. In the latter case rare earth Ga substitution takes partially place. Most of the prepared representatives exhibit carbon (nonmetal) deficiency. The bonding in the perovskite carbides is briefly discussed from the viewpoint of interstitial compounds. (auth)

8321 (LA-DC-9724) URANIUM–CARBON AND PLUTONIUM–CARBON SYSTEMS. Storms, Edmund K. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 46p. (CONF-680924-2). Dep. CFSTI.

From Panel on Plutonium Utilization, Vienna, Austria.

The phase relationship of the U–C system is discussed and previous data are cited on phase diagram and crystal structure. Thermochemical properties of UC, U_2C_3, and UC_2 are summarized. The phase relationship of the Pu–C system is discussed. Thermochemical properties of Pu_2C_3 + C, PuC_2 + C, and PuC + Pu_2C_3 are discussed. A bibliography is included. (J.C.W.)

8322 (ORNL–4370, pp 30–4) PHYSICAL CERAMICS STUDIES. Morgan, C. S. (Oak Ridge National Lab., Tenn.).

Detailed electron microscope observations of dislocations in UO_2 single crystals show large numbers of dipoles and dipole loops after 1% strain, and show dislocation tangles and dipole loops after 5% strain. A study of diffusion of Th in ThO_2 indicates that the diffusion coefficient is smaller near the surface and that grain boundary diffusion is dominant over a wide temperature range. The application of topology to problems in metallurgy is reviewed. Activation energies in sintering of ThO_2 are discussed. Compressive deformation studies of polycrystalline UN and UO_2 are being conducted. (auth)

8323 (ORNL–4370, pp 39–44) SPECTROSCOPY OF IONIC MEDIA. Smith, G. P. (Oak Ridge National Lab., Tenn.).

Optical absorption spectroscopy was used to study the structure and behavior of ionic entities in molten salts, especially those entities formed by transition and posttransition metal ions. The low temperature high-resolution spectra of chloride crystals containing Ni(II) or Co(II) were measured to study the splitting of cubic degeneracies by environments with small distortions from cubic symmetry in order to rationalize results in terms of ligand-field theory. (auth)

8324 (RT/MET–(68)3) MORPHOLOGY OF PHASES PRESENT IN THE UO_2–U_4O_9 SYSTEM. Coppola, F.; Fizzotti, C.; Gandini, A. G. (Comitato Nazionale per l'Energie, Rome (Italy)). 1968. 17p. (In Italian). Dep.

The structures obtained by high-temperature oxidation of $UO_{2.00}$ are shown and described. Slow cooling rates from high temperature yield two-phase structures of $UO_{2.00}$ + U_4O_9. Fast cooling rates at room temperature yield a metastable solid solution that can be decomposed by thermal annealing. (auth)

8325 X-RAY INVESTIGATION OF THE SYSTEM UO_2–UCl_4–KCl. Martynova, N. S.; Tolkachev, S. S. At. Energ. (USSR), 25: 240(Sept. 1968). (In Russian).

Thermographic and x-ray structural analyses were made of UO_2–UCl_4–KCl system. The tabulated roentgenogram of the ternary compound is included. The thermal analysis of the UO_2–UCl_4–KCl system showed that the ternary compound $KCl \cdot UO_2 \cdot UCl_4$ formed from the components of the system in a solid state at 360 to 370°C. (R.V.J.)

8326 PHASE RELATIONS BETWEEN THE TWO VARIETIES OF URANIUM SESQUINITRIDE. Laugier, J.; Martin, J. M. (CEA, Grenoble, France). J. Nucl. Mater., 28: 215–7(1968). (In French).

The isobaric curve at 1 atm. of the equilibrium diagram of the U–N system was derived on the basis of previous experimental data that the cubic α sesquinitride is over-stoichiometric and stable at low temperature and that the hexagonal β sesquinitride is sub-stoichiometric and metastable at low temperature. X-ray diffraction studies at high temperature proved the validity of the diagram proposed. The temperature of the peritectoid decomposition stage of the cubic sesquinitride into hexagonal sesquinitride and nitrogen at a pressure of 1 atm. was fixed at 1130 ± 20°C. (J.S.R.)

8327 TRANSMISSION ELECTRON MICROSCOPE STUDY OF THIN OXIDE FILMS OBTAINED BY OXIDATION OF ZIRCONIUM ALLOYS WITH CONTENT IN THE ADDITION ELEMENT LESS THAN 4 WT. PERCENT. De Gelas, B.; Beranger, G.; Lacombe, P. (Centre de Recherches Metallurgiques, Paris). J. Nucl. Mater., 28: 185–94(1968). (In French).

Thin oxide layers formed by oxidation in oxygen of several binary alloys of zirconium with low content of the addition element (Cu, Fe, Cr, Mo, Al, Nb, Sn) were studied by transmission electron microscopy. The comparison of the results with those obtained previously in the case of pure zirconium made it possible to show the effect of the alloying elements on the morphological and structural characteristics of the oxide film formed during the first stages of oxidation: the observation concerns the microscopic structure of the oxide, the reactivity of the grain boundaries of the alloys, the growth anisotropy, and the orientation of the monocrystalline regions of the oxide, as well as the quantity of cubic zirconia present in place of the monoclinic zirconia. The study of the oxide formed at the level of the precipitates suggests that the precipitates are oxidized less rapidly than the rest of the metallic matrix. (tr-auth)

8328 PHASE EQUILIBRIA IN TERNARY SYSTEMS CONTAINING ZIRCONIA AND SILICA. II. THE SYSTEM Al_2O_3–ZrO_2–SiO_2. Qureshi, M. H.; Brett, N. H. (Univ. of Sheffield, Eng.). Trans. Brit. Ceram. Soc., 67: 569–78(Nov. 1968).

Phase-equilibrium relationships were studied in that part of the Al_2O_3–ZrO_2–SiO_2 system that has hitherto remained largely unexamined. Data are presented on the silica-rich portion of the triangle approximately enclosed by the phases mullite-zircon–cristobalite. The compositions and melting points of three invariant points are reported and a small primary-phase field of zircon is outlined. Isothermal data suggest that the solubility of zirconia in silica-rich melts is low and that the refractoriness of compositions containing 30% or more ZrO_2 by weight does not fall below 1750°C. (auth) (UK)

8329 CARBIDE GRAIN GROWTH DURING THE LIQUID-PHASE SINTERING OF THE ALLOYS NbC–Fe, NbC–Ni, AND NbC–Co. Warren, R. (Hardmetal Research Lab., Soederfors, Sweden). J. Less-Common Metals, 17: 65–72(Jan. 1969).

An investigation was made of microstructural changes that occur during the liquid-phase sintering of NbC-22 wt % Fe and NbC-22 wt % Ni alloys. Growth of the carbide grains, dispersed in either of the liquid metals, is consistent with the theoretical equation, derived by Wagner, for a solution/precipitation growth process controlled by diffusion of the solid constituent through the liquid. The same growth behavior was observed earlier in a similar alloy of NbC in cobalt. The effect of temperature on grain growth was measured and "activation energies" of the growth rates were determined. (auth)

8330 TERNARY CARBIDES IN THE SYSTEM U–M–C. Holleck, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 28: 339–40(1968). (In German).

In the system U-M-C, the reaction behavior of the UC-M section was determined by formation of a ternary phase. At high platinum metal concentrations formation of the phases URu_3, UOs_2, URh_3, and UPt_3 was observed. Tetragonal phases U_2RuC_2, U_2OsC_2, U_2RhC_2, U_2IrC_2, and U_2PtC_2 were observed. (M.C.G.)

8331 STUDY OF THE SYSTEM Gd_2O_3–HfO_2 IN THE REGION RICH IN HAFNIUM DIOXIDE. Isupova, E. N.; Glushkova, V. B.; Keler, E. K. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1732–7 (Oct. 1968). (In Russian).

The reaction of gadolinium oxide with hafnium dioxide was studied in the temperature range up to 1900°C. Beginning at 7 mole % concentrations of Gd_2O_3 at temperatures above 1500°C, a cubic solid solution of the fluorite type was formed. The behavior of products from coprecipitation of gadolinium and hafnium hydroxides at 250 to 1700°C was studied. The existence of metastable low-temperature cubic solid solutions with fluorite type structure was discovered at Gd_2O_3 concentrations from 2 to 33 mole %. The phase diagram was constructed and the two-phase field was limited to fluorite-type cubic solid solution and monoclinic solid solution. Formation of compounds in the system was not established. (tr-auth)

8332 CONTRIBUTION TO THE ZIRCONIUM–CARBON SYSTEM. Nickel, Hubertus; Inanc, Oezel; Luecke, Kurt (Kernforschungsanlage, Juelich, Ger. Technische Hochschule, Aachen). Z. Metallk., 59: 935–40(Dec. 1968). (In German).

The phase range of zirconium-carbide was determined by metallographic and x-ray examinations as well as by the use of an electron-microprobe analyzer. The last method was also used to analyze the ZrC phase of alloys which were in equilibrium with zirconium-metal or (ZrC + C) eutectic. On the basis of these results, one can say that the homogeneity range of zirconium carbide begins at 38.4 at. % C ($ZrC_{0.62}$) as the lower limit and ends at 50.0 at. % C (ZrC) as the upper limit. In the homogeneity range, the lattice parameter first rises with the increase of the carbon content (>38.4 at. % C), reaches a maximum with a = 4.7014 ± 0.0002 Å at 46.14 at. % C for the samples not heat-treated and with a = 4.7004 ± 0.0002 Å at 46.0 at. % C for the heat-treated samples, and decreases with further increase in carbon content. The lattice parameter remains constant below 38.4 at. % C (a = 4.6934 ± 0.0004 Å) and above 50.0 at. % C (a = 4.6983 ± 0.0003 Å). ZrC forms, with the metastable zirconium oxide (ZrO) and the nitride (ZrN), $ZrC_xO_yN_z$ solid solutions. The investigation has shown that the "built-in" oxygen and especially the nitrogen reduce the lattice parameter of zirconium carbide. (auth)

8333 PHASE DIAGRAM OF THE SYSTEM ZIRCONIUM–ZIRCONIUM NITRIDE–ZIRCONIUM CARBIDE. Danisina, I. N.; Vil'k; Yu. N.; Avarbe, R. G.; Omel'chenko, Yu. A.; Ryzhkova, T. P. Zh. Prikl. Khim., 41: 492-500(1968). (In Russian).

Samples 2.4 mm in diameter and 35 mm long were pressed by known methods from powder-form zirconium carbide and zirconium nitride. Isothermal annealing of alloys of the path ZrN–$ZrC_{0.25}$ was done in purified argon at 1600, 1900, 2100, and 2200°C, and of alloys of the path $ZrN_{0.818}$–$ZrC_{0.923}$ in a stream of purified nitrogen at 2400 and 2600°C. Heating was effected with an electric current passing through the sample, and cooling in jets of the above-mentioned gases. The temperature was measured with a Type MOP-48 micro-optical pyrometer. Tabulated results were used to construct a phase diagram at 1600°C. Assuming values from previous work for the fusion entropies of $ZrN_{0.818}$ and $ZrC_{0.923}$, a calculation was made of their heats of fusion. Results were: for $ZrN_{0.818}$—20,495 cal/gram mole; for $ZrC_{0.923}$—23,875 cal/gram mole. (ATD)

8334 IN-PILE MEASUREMENT OF STRUCTURAL AND STOICHIOMETRIC EFFECTS ON UO_2 THERMAL CONDUCTIVITY. Balfour, M. G.; Ferrari, H. M. (Westinghouse Electric Corp., Pittsburgh). Contract NAS-3-4589-PB. Met. Soc. Conf., 42: 223-35(1966).

Experimental evidence has shown an increase in uranium dioxide thermal conductivity at high temperatures; however, considerable controversy exists over the heat-transfer mechanism responsible. An in-pile study of the effects of columnar grain growth and hypostoichiometry on uranium dioxide thermal conductivity was performed to provide mechanistic information on the above behavior. Columnar grain formation had no significant effect on UO_2 thermal conductivity between 1700 and 2150°C, contrary to a postulated enhancement of thermal conductivity by radiant transmission. Results show that the average thermal conductivity of $UO_{1.941}$ during irradiation is nearly 20% higher than $UO_{2.005}$ between 600 and 2250°C. This result is consistent with a theoretically predicted enhancement of uranium dioxide thermal conductivity by a high-temperature electronic contribution to heat transfer. (auth)

8335 CHEMICAL PROPERTIES AND BEHAVIOR OF URANIA ABOVE 1500°C. Fryxell, R. E. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Met. Soc. Conf., 42: 211-21 (1966).

The phase diagram for the uranium-oxygen system and related thermodynamic properties are briefly reviewed for the oxygen deficient fluorite structure, UO_{2-x}. These data are discussed in relation to the nominal environmental equilibrium requirements for maintaining the stoichiometric UO_2 composition at high temperatures and the relative effectiveness of various refractory metals as an oxygen barrier to prevent loss of oxygen from stoichiometric UO_2. Rhenium is a better barrier than Mo, W, or Ta, and W-30Re-30Mo is about the same as pure tungsten. (auth)

8336 HIGH-TEMPERATURE X-RAY DIFFRACTION STUDIES OF THE TERBIUM OXIDE–OXYGEN AND MIXED CERIUM TERBIUM OXIDE–OXYGEN SYSTEMS. Burnham, D. Arthur; Eyring, LeRoy; Kordis, J. (Arizona State Univ., Tempe). J. Phys. Chem., 72: 4424-31(Dec. 1968).

High-temperature x-ray diffraction was used to study the stability regions of intermediate phases in the terbium oxide–oxygen and the mixed cerium terbium oxide–oxygen systems and to clarify the nature of chemical hysteresis and "pseudophase" phenomena in such systems. These isobaric x-ray diffraction studies of the terbia system confirmed the major features of the phase diagram gained from previous tensimetric work. Also, in both isothermal and isobaric studies the presence of hysteresis was confirmed. Hysteresis loops encompassed diphasic regions and the composition of the ordered phases of narrow homogeneity range in diphasic regions remained virtually constant with temperature. X-ray diffraction traces also showed that the pseudophases seen in oxidation were diphasic mixtures of the same two phases seen in reduction. In the ternary system ($Ce_{0.7}Tb_{0.3}O_x$) studied, no diphasic regions were observed. The resolution found in x-ray patterns of terbia, which distinguished the different phases, was lost when ceria was admixed. Line broadening in the x-ray diffraction patterns was thought to be a combination of incipient phase transition of the terbia in the mixed oxide and variations in homogeneities of the crystallites because of the presence of cerium. (auth)

8337 HIGH TEMPERATURE STRUCTURE AND ELECTRIC CONDUCTIBILITY IN ZrO_2–Y_2O_3–Ta_2O_5 SYSTEM. Caillet, Marcel; Deportes, Charles; Robert, Guy; Vallier, Guy; Vitter, Gerard (Ecole Nationale Superieure d'Electrochimie et Electrometallurgie, Grenoble, France). Rev. Int. Hautes Temp. Refract., 5: 173-9(July-Sept. 1968). (In French).

A crystallographic approach shows a solid solution of fluorite type in a wide scale of composition, if the difference (mole 100 $YO_{1.5}$ – mole 100 $TaO_{2.5}$) remains above 12%. The electric conductivity was measured in the air between 800 and 1,350°C. It always remains below the maximal conductivity in ZrO_2–Y_2O_3 system. All isothermal curves drawn for conductivity in terms of composition with constant rate of ZrO_2, show a maximum, for which the abscissa depends on ZrO_2 concentration. The results may be explained if Ta_2O_5 is considered as a suppressor of vacancies. (auth)

Radiation Effects

Refer also to abstracts 8265, 8272–8274, 8302, 8305, 8306, and 9177.

8338 (GA–7000) ADVANCED GRAPHITE FUEL SYSTEMS. Quarterly Progress Report for the Period Ending February 14, 1966. Bokros, J. C.; Engle, G. B.; Goeddel, W. V.; Price, R. J.; White, J. L. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 15, 1966. Contract AT(04-3)-167. 50p. Dep. CFSTI.

The relationship between pitch binder content and the microstructure, preferred orientation, and physical properties of graphite prepared by a standard molding process show that increasing pitch content results in a decrease in bulk anisotropy of molded bodies containing uncalcined needle coke. Micrographic studies on binder-filler graphite molded at 120°C, baked at 500°C, heat-treated between 550 and 900°C show that microstructure characteristics are established early in the production process. Irradiated carbons and carbons containing codeposited Ti are being studied. Results of dimensional changes in irradiated molded binder-filler graphites indicate that effects are temperature sensitive at 1400 to 1550°C. Terminal stresses and irradiation creep constants in pyrolytic carbon were estimated by "bracketing" the creep constants of $\sim 9 \times 10^{-7}$ $(psi)^{-1}$ $(10^{20}$ $nvt)^{-1}$ were found. Damage by fission-recoil atoms were studied and found to be extensive. A substantial portion resulted from nucleation and growth of fission gas bubbles. (F.S.)

8339 (ORNL–4370, pp 179-92) HIGH FLUX ISOTOPE REACTOR MATERIALS DEVELOPMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Progress is reported on HFIR fuel element fabrication, post-irradiation examination of HFIR fuel elements, advanced fuel plate fabrication, welding, and fabrication of HFIR control elements. (J.R.D.)

8340 (ORNL–4370, pp 193-7) HIGH FLUX ISOTOPE REACTOR TARGET DEVELOPMENT. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

Information is included concerning progress on TRU target fabrication, HFIR target performance, TRU inspection and radiation effects on Al. (J.R.D.)

8341 (ORNL-TM–2278) GCR-ORR LOOP 1 FUEL ASSEMBLY NO. 14: AN IRRADIATION TEST OF LARGE LOOSE BEDS OF PYROLYTIC-CARBON-COATED SOL-GEL OXIDE PARTICLES. Longest, A. W.; Conlin, J. A.; Cuneo, D. R.; Long, E. L. Jr.; Osborne, M. F. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 79p. Dep. CFSTI.

An irradiation experiment to study the behavior of relatively large beds of loose coated-particles in graphite was conducted. The experimental assembly consisted of two capsules aligned one above the other in the loop. The fuel in both capsules consisted of a mixture of two batches of pyrolytic-carbon-coated sol-gel oxide particles. One of the batches had ThO_2 cores, and the other $(Th,U)O_2$ cores, the latter with a thorium-to-uranium (fully enriched) ratio of 11.9. The upper capsule was vented to the loop coolant for fission-gas release determination and contained, in addition to 57.6 g of fuel particles, BeO pellets in contact with graphite for study of compatibility. The lower capsule was sealed and provided a simultaneous irradiation of a smaller quantity of coated particles (3.4 g) at a reduced temperature. The fuel was irradiated for 216 days at a maximum temperature between 1270 and 1380°C. The loop coolant was helium and mixtures of helium and neon. Heavy-metal burnup of the $(Th,U)O_2$ particles was 3.0 at. %, and consumption of ^{235}U atoms was 48%. The exposure to fast neutrons (E > 0.18 MeV) was about 7×10^{20} neutrons/cm^2. Both batches of particles performed well. There were no serious problems associated with the large loose bed. The retention of gaseous fission products was satisfactory ($R/B \approx 10^{-5}$), and analysis of the components of the upper capsule indicated the coatings were effective in retaining nongaseous fission products. Mild

oxidation of the graphite parts and pitting of the fuel particle coatings in the upper vented capsule occurred as a result of abnormally high contaminant levels in the loop coolant during irradiation. No evidence of a compatibility problem between BeO and graphite (at ~1300°C) was found, and no significant shrinkage of ATJ graphite that could be attributed to radiation damage was detected. (auth)

8342 (ORNL-TM-2336) COMPARISON OF OBSERVED AND PREDICTED IRRADIATION PERFORMANCE OF PYROLYTIC-CARBON-COATED URANIUM DIOXIDE PARTICLES. Reagan, P. E.; Hewette III, D. M.; Morgan, J. G. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

A mathematical model developed to predict coated particle failure of coated particles during irradiation was tested. A test capsule containing uranium oxide particles with pyrolytic carbon coatings of 55 to 163 microns thickness was irradiated at 1250°C. The coatings were predicted to fail at 9% burnup, but only 7% burnup was attained because auxiliary particles, used to heat the capsule, began to fail. In a second test, the mathematical model predicted coating failure at 7.8% burnup at 1400°C, and these particles began to fail at 7.5% burnup. (auth)

8343 (WAPD-TM-630) SHORT-TERM IRRADIATED OF ZIRCALOY-4 CLAD FUEL RODS CONTAINING LOW-DENSITY OR ANNULAR ZrO_2–UO_2 CERAMIC FUEL PELLETS: X-1-t TEST. LWBR-LSBR Development Program. Meieran, H. B.; Bourgeois, W. F.; Engel, J. T. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT(11-1)-Gen-14. 202p. Dep. CFSTI.

The X-1-t irradiation test was a pilot test in the development of Zircaloy-clad bulk-oxide fuel elements having high thermal and depletion ratings for the LSBR program. The test was run on fuel rods containing ZrO_2-47 wt % U^EO_2 fuel pellets; the rods contained either 94% TD annular pellets or 84% TD solid pellets. The test was terminated after 7 days when one of the solid, low-density rods failed, due to attack of molten fuel on the clad with resulting clad melting and burnout. There was severe internal hydriding of the failed clad, and all rods showed internal ZrO_2-type corrosion products, attributed to O_2 pickup by Zircaloy at high temperatures. The solid, low-density rods showed gross fuel redistribution and fuel pellet melting. The annular pellets did not melt, but did show some fuel redistribution. Structural changes are estimated at 90% in the solid fuel and 15% in the annular fuel. The solid rods showed a post-irradiation ovality of cladding, with small depressions (dimples) on the minor axis of the oval. The cladding of the unfailed rods had an unusually large hydrogen pickup, which was not consistent with the small amount of external corrosion of the rods. (auth)

8344 IRRADIATION OF GRAPHITE AT LOW TEMPERATURE BY NEUTRONS AND BY ELECTRONS. MEASUREMENT OF STORED ENERGY AND OF VARIATION IN ELECTRICAL RESISTIVITY. Bochirol, L.; Bonjour, E. (CEN, Grenoble, France). Carbon, 6: 661-9(Oct. 1968). (In French).

Different types of graphite were irradiated either with pile neutrons (27 and 77°K) or with electrons (20.4°K). Diagrams obtained from stress-annealed pyrographites, as-deposited pyrographite, and conventional nuclear graphite gave a good definition of the released energy profile between 40 and 670°K. They show a dependence on the graphitization degree. The three first stages of stored energy are analyzed in relation to the electrical resistivity anti-annealing stages. An evaluation of Frenckel's pair formation energy is given for both types of irradiations. (auth) (UK)

8345 EFFECTS OF NEUTRON IRRADIATION ON THE COMPOSITE MATERIAL GRAPHITE–PYROCARBON OBTAINED BY PYROLYSIS OF NATURAL GAS. Bochirol, L.; Brauns, P. (CEN, Grenoble, France). Carbon, 6: 671-9(Oct. 1968). (In French).

The preparation and main characteristics of composite graphite/pyrocarbon bodies, designated BB5G, and obtained from thermal cracking of natural gas at about 1000°C under normal pressure are briefly reviewed. Dimensional changes induced by neutron irradiation in these materials were measured. Irradiation temperatures were approximately 60, 350, and 450°C, and fast neutron doses were respectively about 4×10^{20} n/cm^2 for the lowest temperature, and 1.1 to 1.3×10^{21} n/cm^2 for the two higher temperatures. Expansion was observed at 60°C (3.0% for the maximum dose received), but a shrinkage was observed for 350 and 450°C irradiations (0.7 to 1.0%). The behavior of BB5G is compared with that of conventional nuclear graphites. The use of the former material should be feasible for structural parts in nuclear reactors. Some remarks are made concerning the bulk behavior of such composite bodies. (auth) (UK)

8346 INFLUENCE OF CRYSTAL PERFECTION ON DEFECT NUCLEATION IN GRAPHITE IRRADIATED AT HIGH TEMPERATURES. Thrower, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 6: 687-93(Oct. 1968).

Graphite single crystals and two specimens of pyrolytic graphites of differing perfections were simultaneously irradiated at 1350°C to 11.7×10^{20} n/cm^{-2}, and the defects produced were examined by transmission electron microscopy. There were very significant differences in the defects nucleated in the three materials, and this is attributed to the presence of twist boundaries in the pyrolytic materials. In these positions interstitials form large low energy loops and the vacancies are allowed to nucleate homogeneously in the lattice. From an analysis of these effects the migration energies of an interstitial perpendicular to the basal plane ($E^i_{mc} = 2.8 \pm 0.2$ eV) and a vacancy in the basal plane ($E^v_{ma} = 3.1 \pm 0.2$ eV) can be calculated. These results confirm earlier reports of c-axis diffusion, and the significance of this for defect nucleation in polycrystalline reactor graphites is discussed. (auth) (UK)

8347 EFFECT OF NEUTRON-BOMBARDMENT ON THE REACTIVITY OF GRAPHITE TO OXYGEN. Harker, H.; Horsley, J. B.; Parkin, A. (Univ. of Newcastle-upon-Tyne, Eng.). J. Nucl. Mater., 28: 202-10(Nov. 1968).

The effect of neutron-bombardment on the reactivity of graphite to oxygen has been investigated using a static apparatus operating at low pressure (10^{-1} Torr). Bombardment introduces large numbers of unpaired electron centers, detectable by electron spin resonance (ESR), but these do not appear to function as active sites directly. In moderator specimens irradiated in carbon dioxide, the reactivity change was small enough to be obscured by mechanical damage introduced in the process of powdering the material. Irradiation of graphite in vacuum led to a marked increase in the rate of formation of carbon dioxide subsequently formed in reaction with oxygen and this is mainly attributed to preferential combustion of trapped interstitial species, the existence of which has come to light during the ESR work. The effect of neutron-irradiation on the formation of carbon monoxide is rather smaller and a different type of defect is believed to be responsible in this case, though its nature is not yet known. (auth) (UK)

8348 IRRADIATION TESTING OF UO_2 FUEL ELEMENTS CONTAINING BURNABLE POISON ADDITIONS. Christopher, S. S.; Koziol, J. J.; Mahagin, D. E. (Combustion Engineering, Windsor, Conn.). Nucl. Appl., 6: 47-55(Jan. 1969).

Two fuel elements containing 0.05 wt % B_4C in 6% enriched UO_2 fabricated by vibratory compaction to densities of 88 ± 1% of theoretical with local boron concentrations maintained within a variation of about ±20% of the nominal loading, were irradiated in the Saxton reactor to burnups of ~1000 and 5000 MWd per metric ton of uranium at peak heat ratings of 17.2 and 19.8 kW/ft, respectively. The post-irradiation examination revealed no significant dimensional changes in either element and no axial boron redistribution of any consequence. However, the boron migrated radially outward in both irradiated fuel elements. The boron redistribution does not appear to be a function of burnup but depends heavily on the thermal gradient during irradiation. Its effect on core physics was analyzed using the THERMOS Program, and the changes in η_f (ratio of neutrons produced to thermal neutrons absorbed) and $\Delta\rho$ (difference in core reactivity) were found to be minimal. (auth)

8349 PLUTONIUM FUELS FOR FAST REACTORS. Parkinson, N. (United Kingdom Atomic Energy Authority, Thurso, Scotland). Met. Soc. Conf., 42: 297-309(1966).

Plutonium fuel development for the United Kingdom's Prototype Fast Reactor has been concentrated on the mixed uranium–plutonium oxides and carbides. Methods of preparation and fabrication of these fuels and of fuel elements have been studied and an irradiation program carried through in the Dounreay Fast Reactor to investigate the effect of fuel properties, such as density, form, and chemical composition on in-pile behavior. Additionally, work has been undertaken on the stability of the fuel compounds with molten sodium, and on problems arising in the re-cycling of high burnup fuels to give highly decontaminated products suitable for refabrication behind light shielding. The results of these investigations are presented and discussed. (auth)

8350 RADIATION PERFORMANCE OF PLUTONIUM–URANIUM MONOCARBIDE FAST REACTOR FUELS. Bradbury, B. T.; Frost, B. R. T. (Atomic Energy Research Establishment, Harwell, Eng.). Met. Soc. Conf., 42: 329-52(1966).

Plutonium–uranium monocarbide is one of the more attractive fuels for use in sodium-cooled fast reactors. Many of the fabrica-

tion and fuel and cladding compatibility problems have been solved. The remaining problem is the definition of its behavior in a reactor environment. In an attempt to answer this problem, miniature fuel elements, 1 inch to 4 inches long and 0.1-in. to 0.25-in. diameter, are being irradiated in a thermal materials testing reactor at Harwell and in the Dounreay Fast Reactor (DFR). The objective was to establish the level of fission gas release from materials of differing compositions and densities. Results from fourteen elements showed that the level of gas release was around 1.0%, at 5% burnup of heavy atoms and a center temperature of about 1200°C, and at 10% burnup for a center temperature below 900°C. The restraint exercised by the cladding in all these experiments was sufficiently high to prevent significant fuel swelling. One fuel has been selected (sintered, single phase) for extensive study over a range of center temperatures, restraint, and burnup. It is hoped that such a study will reveal the best design philosophy for carbide fuel. (auth)

8351 BERYLLIUM OXIDE FOR NUCLEAR APPLICATION. Smith, R. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). Met. Soc. Conf., 42: 379-402 (1966).

A review is presented of recent work on the properties and performance of beryllia. Attention is confined mainly to one grade of beryllia with a grain size less than 5 microns and a density of 2.86 to 2.90 g cm^{-3}, fabricated by isostatic-pressing and sintering from sulphate-derived powder. Topics considered include fabrication, microstructure and permeability, thermal expansion and thermal conductivity, mechanical behavior and properties, and the effects of irradiation. The main limitation on the use of beryllia as a nuclear material is still the fast neutron dose that the material will withstand without microcracking. This limitation is less severe at high temperatures and can be overcome if the material can be annealed periodically at 1000°C to remove accumulated strain. (auth)

8352 ADVANCED BeO FUEL STUDIES. Meyer, R. A.; Lofftus, F. H.; Goodjohn, A. J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-187. Met. Soc. Conf., 42: 403-20(1966).

A program was undertaken to investigate different methods of fabricating the pellets of BeO containing up to 25 vol % of uranium or uranium–thorium fuel particles so the fuel would have good fission product retention characteristics up to 1650°C and linear heating rates up to 20,000 BTU/hr ft. The fuel pellets were fabricated by isostatically cold pressing and sintering or by hot pressing methods. In some cases the BeO matrix densities were in excess of 99.4% of theoretical and the beginning of life fractional release values for Xe and Kr were as low as 7×10^{-8} after 1 hr. The irradiation characteristics of these fuels and factors affecting the fission product retention characteristics are discussed. (auth)

8353 VALUE OF A SILICON CARBIDE BARRIER IN HIGH-TEMPERATURE REACTOR FUELS. de Nordwall, H. J.; Sayers, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). Met. Soc. Conf., 42: 65-84(1966).

Silicon carbide was initially selected as a fission product retaining barrier because of its small interatomic spacings, low neutron capture cross section, and good thermal conductivity. In coated particle fuels, silicon carbide was used as a sandwich between two layers of pyrocarbon to avoid possible loss of silicon at high temperatures and damage by recoiling fission fragments. This triplex type of coating when combined with a low-density, sintered dicarbide fuel kernel has led to a fuel combination which can withstand burnups of at least 12% fissions per initial metal atom FIMA up to 1600°C. The experimental work carried out for the Dragon Project to prove the particle design is described. Laboratory experiments on fission gas release and later analyses of the fission products found in high burnup irradiation capsules showed that coatings containing a SiC layer could release as little as one-hundredth of the strontium, barium, and cerium released by pyrocarbon coatings. Fission gas release was unaffected, but the uranium concentration near the outer coating surfaces was lower for particles with a SiC barrier, because of reduced uranium migration during manufacture. (auth)

8354 HTGR COATED PARTICLE FUEL. Goeddel, W. V.; Bokros, J. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Met. Soc. Conf., 42: 85-104(1966).

Comprehensive studies of coated particle fuels for the High-Temperature Gas-Cooled Reactor have been continued. These studies are directed toward identifying and quantitatively defining the structural and environmental parameters influencing the behavior of pyrolytic-carbon-coated carbide fuel particles under conditions of high temperature (1000 to 1500°C), high burnup (10 to 20 at % heavy metal), high fast flux dose [$>10^{21}$ nvt (E > 0.18 MeV)] irradiation. Systematic studies of the relationship between the structure of pyrolytic carbon and its behavior under irradiation show that the most irradiation-stable carbon coatings will be those that are free of any preferred orientation, have densities as near theoretical as possible, and have maximum crystallinity to minimize irradiation-induced crystallite strains. Extensive irradiation testing of pyrolytic-carbon-coated carbide fuel particles shows that their stability is dependent on both environmental conditions (temperature and burnup) and material parameters (coating structure and geometry). Two- and three-layer pyrolytic-carbon coatings that have a low-density innermost layer and high-density isotropic outer layers have shown good stability during 10% to over 20% burnup of metal atoms at temperatures to over 1400°C. (auth)

8355 DRAGON REACTOR FUEL. Huddle, R. A. U. (OECD High-Temperature Reactor Project, Winfrith, Eng.). Met. Soc. Conf., 42: 119-44(1966).

The early development of the coated particle fuel concept is outlined in relation to the aims and objectives of the Dragon Project fuel element development program. The advantages of this type fuel are discussed with respect to the Dragon Reactor Experiment and for power reactors. The fuel elements irradiated in the first charge are described; particular emphasis is placed on the experimental elements and their behavior under operational conditions. Details are given to illustrate the excellent performance of these elements during the 10-MW run and during the initial sustained operation at full power (100 days at 20 MW). Modifications to fuel element design are described to illustrate how the reactor has been transformed into a flexible and extremely efficient tool for fuel element development. Reference is made to the second charge to illustrate how this increased experimental facility had been utilized, and how the important parameters of fuel elements for power reactors can be investigated and their performance under operational conditions proved. (auth)

8356 SAP CLAD URANIUM CARBIDE FUEL ELEMENTS. MacDonald R. D. (Chalk River Nuclear Labs., Ont.); Mathers, W. G.; Tachis, A. M.; May, J. E. Met. Soc. Conf., 42: 165-81(1966).

Uranium carbide is a potential fuel for organic-cooled power reactors. To study its behavior, ten SAP (sintered aluminum product, 7% Al_2O_3) sheathed UC elements, with argon filler-gas, were irradiated at linear power ratings to 1040 W/cm, in the organic-cooled loop of NRX. The composition of the arc-cast 14.0-mm dia pellets varied from 4.6 to 4.8 wt % carbon, with most pellets between 4.6 and 4.7 wt % carbon. Each element contained six UC pellets in a finned SAP tube. Fuel burnup ranged from 3450 to 11,100 MWd/teU. The test has helped to establish the irradiation behavior of gas-filled UC fuel elements. Separate correlations between fuel swelling and temperature or burnup were not obtained; within the range investigated there was little effect of composition on swelling. The test demonstrated the mobility of free uranium at high temperatures and the tendency of uranium to concentrate in void spaces. Where these concentrations could adversely affect element integrity, careful control of the carbon content would be required. (auth)

8357 STOICHIOMETRY EFFECTS IN MOLTEN CENTER, OXIDE FUELS: OXYGEN REDISTRIBUTION AND THERMAL CONDUCTIVITY EFFECTS. Christensen, J. A.; de Halas, D. R.; Horn, G. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Met. Soc. Conf., 42: 185-206(1966).

Temperature distributions in 100% dense UO_{2+x} fuels during molten center irradiation were determined as functions of composition for $-0.10 \leq x \leq 0.15$. Radial oxygen redistribution was measured in $UO_{2.00}$, $UO_{2.02}$, $UO_{2.05}$, and $UO_{2.15}$ by remotely performed coulometric analyses of samples removed with diamond core drills. It was found that the heat rating required to initiate center melting decreases continuously with O:U atomic ratio between 1.90 and 2.15 and the decrease in heat rating required for fuel melting as oxygen content increases reflects principally the decrease in melting point as O:U increases above 2.00. Migration of oxygen to the molten center occurred for O:U's > 2.00, presumably because of higher oxygen solubility in the melt in equilibrium with the solid. In general, center melting appears to reduce the effects of departures from stoichiometry on fuel properties since the excess component segregates to the melt. (auth)

8358 PERFORMANCE OF UO_2 FUEL WITH CENTRAL MELTING. Weidenbaum, Bernhardt; Pashos, Thomas J.; Lyons, Mark F. (General Electric Co., Pleasanton, Calif.). Met. Soc. Conf., 42: 207-9(1966).

The irradiation of capsules and rods at incremental heat fluxes in the range from 190 to 440 W/cm^2 [$(0.6 - 1.4) \times 10^6$ Btu/hr-ft^2]

provided the original basis for utilizing UO_2 as a molten fuel and evaluating experimentally the possible problem areas that could impose an operating limit with this mode of fuel operation. The feasibility of using UO_2 as a fuel with a portion of it in the molten state was demonstrated by the irradiation of a four-rod assembly to a significant burnup at a specific power of 37 kW/ft in a pressurized loop. The rods had a fuel geometry of interest for power reactors with bulk UO_2 and Zr-2 cladding. Two rods with vibratory compacted, arc-fused powder attained a burnup of 6×10^{20} fissions/cc and two rods loaded with cored pellets a burnup of 3×10^{20} fissions/cc. Attainment of higher heat fluxes, and thereby the program goal of obtaining the operating limit of UO_2 as a fuel, was not possible because of operational limitations of the loop. (auth)

8359 IRRADIATION STUDY OF UO_2–STAINLESS STEEL AND $(Pu, U)O_2$–STAINLESS STEEL CERMET FUELS IN ROD AND PLATE GEOMETRY. Lambert, J. D. B. (Atomic Energy Research Establishment, Harwell, Eng.). Met. Soc. Conf., 42: 237-54(1966).

Three irradiations have been made to determine the dimensional stability of miniature cermet elements containing 30 to 60 vol % oxide dispersed in, and clad with, type-316L stainless steel. The specimens irradiated were clad plates and rods containing spherical UO_2 particles and sealed cans of pellets containing angular and spherical $(Pu,U)O_2$ particles. Surface temperatures varied from 500 to 675°C and burnups were in the range 1 to 10% of heavy atoms After irradiation, the UO_2-stainless steel plates and rods had undergone volume increases, which were caused by a swelling rate in the UO_2 of about 2% per 1% burnup of uranium atoms, although initially the matrix had forced the UO_2 to swell into its own voidage. In contrast, the $(Pu,U)O_2$-stainless steel rods exhibited no measurable dimensional change, and in these elements both the initial particle density and burnups were such that no appreciable swelling occurred in the cermet pellets. Thus, particle voidage in a cermet appears to delay the onset of serious swelling. Cermet rods are probably more stable than plates because, once particle swelling has caused failure of the steel matrix, plates crack along their centerplane and bulge appreciably, whereas rods fail uniformly by surface cracking. (auth)

8360 RADIATION STABILITY OF URANIUM MONONITRIDE. Storhok, V. W.; Martin, R. L.; Gates, J. E. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 42: 255-74(1966).

The irradiation characteristics of UN, fabricated by various techniques and clad with Type 316L stainless steel, were studied at surface temperatures up to about 750°C and uranium burnups of 6.3 at. % (2.2×10^{21} fissions/cm^3). Diametral swelling of clad specimens varied from 1.3 to 4%. No clear-cut relationships between swelling characteristics and fabrication technique were observed. Fractional fission gas releases ranged up to 26%. Hydrogen resulting from $^{14}N(n,p)^{14}C$ reaction was almost totally released from the UN, but significant fractions were retained within soundly clad specimens. About one-half the stainless steel claddings exhibited very small cracks of unknown origin. (auth)

8361 IRRADIATION BEHAVIOR OF UO_2–PuO_2 FUELS IN PRTR. Freshley, M. D.; Panisko, F. E.; Skavdahl, R. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT-(45-1)-1830. Met. Soc. Conf., 42: 277-96(1966).

The irradiation behavior of full-sized, mixed-oxide (UO_2-PuO_2) fuel elements is being investigated under power reactor conditions. Melting in vibrationally compacted UO_2–2 wt % PuO_2 fuel commences at a linear rod power of 20 to 21 kW/ft. Melting is evidenced by the formation, on cooling, of a well-defined cellular structure in the thermal center of the fuel rod. Melting usually results in axial fuel relocation. Although the defect behavior of vibrationally compacted UO_2-PuO_2 fuel rods has been excellent at lower power generations (i.e., up to ~24 kW/ft), a "rupture threshold" may have been reached at high power generations (in the neighborhood of 27 kW/ft). Behavioral differences in phenomena, such as fuel oxidation and plutonium migration, have been indicated between nondefected and defected UO_2-PuO_2 fuel rods. Fission gas release values as high as 88% have been measured in vibrationally compacted UO_2-PuO_2 fuel rods that were operated with volumetric average fuel temperatures of approximately 2200°C. (auth)

8362 IRRADIATION BEHAVIOR OF GRAPHITE. Nettley, P. T.; Martin, W. H. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Met. Soc. Conf., 42: 29-43(1966).

The results of previous experiments on the radiation behavior of different graphites and recent studies of the defects produced in graphite crystals by fast neutron irradiation have led to the development of an irradiation damage model for graphite. Several graphites, including well-oriented pyrolytic material, have been irradiated to total neutron doses of up to 3.3×10^{22} n cm^{-2} in the Dounreay Fast Reactor. The irradiation temperature range was 380 to 750°C. The resultant dimensional and physical property changes have been studied and their general agreement with a damage model is good. Published data on the irradiation behavior of graphite above 750°C have also been examined and arguments are presented to show that they are in general agreement with the proposed damage model. (auth)

8363 STUDIES ON A FUEL FOR AN ORDERED BED REACTOR. Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.); Pancer, G. P.; Holden, R. B. Met. Soc. Conf., 42: 467-80(1966).

The irradiation behavior of a low-density (85% theoretical density) UO_2–stainless steel cermet fuel for a fast breeder reactor concept has been investigated. The effects of thermal stress were determined at burnups as high as 3.4 at. % (metal atoms) and thermal stresses as high as 37,000 psi. No cracking and only small dimensional changes were noted in the irradiated fuel pellets. (auth)

8364 RECOVERY OF THE BASAL PLANE ELECTRICAL RESISTIVITY IN ELECTRON-IRRADIATED PYROLYTIC GRAPHITE. Iwata, T.; Nihira, T.; Ohmichi, T. (Japan Atomic Energy Inst., Tokai). Carbon, 6: 742-4(Oct. 1968).

Results are presented of an experiment to clarify the structure of recovery stages in electron irradiated graphite by measurement of changes of basal plane electrical resistivity of pyrolytic graphite. Isochronal and isothermal annealing experiments were performed after irradiation at 0.7 and 1.4 MeV at 80°K. Isochronal recovery curves are shown and the recovery features demonstrated in the case of 1.4 MeV irradiation by a simple numerical derivative of the recovery curves with respect to temperature. Recovery was considered in 4 stages, between 85 and 250°K, and the annealing kinetics were studied at each stage by isothermal annealing experiments. The activation energy and frequency factor observed at each stage for irradiation at 1.4 MeV to an integrated flux of 2.5×10^{17} electrons/cm^2 are tabulated. (UK)

Plastics and Other Materials

Refer also to abstracts 7555, 7723, 9117, 9118, and 9137.

8365 (CONF-681020–(Vol.1), pp 197-206) POLYMORPHISM IN HEAVY RARE EARTH DICARBIDES AT HIGH PRESSURES AND TEMPERATURES. Krupka, M. C.; Krikorian, N. H.; Wallace, T. C. (Los Alamos Scientific Lab., N. Mex.).

Heavy rare earth dicarbides were shown to exist in both cubic and tetragonal modifications of the crystal lattice. A new but more complex structure for LnC_2 (where Ln equals Tb, Dy, Ho, Er, Tm, Yb, and Lu as well as Y) was prepared. Standard annealing techniques were used where possible. The use of high-pressure methods to enhance the rate of formation of these structures and to synthesize those that could not be prepared by the former method was demonstrated. The tetragonal stability range for select dicarbides was determined. Lattice parameters for the new phases tentatively indexed to orthorhombic geometry were calculated. (auth)

8366 SURFACE MATERIALS OF NUCLEAR POWER AND RI HANDLING FACILITIES: PAINTS. Wadachi, Yoshiki; Yasunaka, Hideo (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 17: 573-7(Dec. 1968). (In Japanese).

Radioactive contamination protective paint must have small contaminability and large decontaminability. Using $^{233}UO_2(NO_3)_2$ acidic aqueous solution as the radioactive contaminant, paints and coating surfaces were examined for conditions influencing their protective qualities. Results showed that some kinds of epoxy resin paints, vinyl chloride resin paints, and chlorinated rubber paint gave small contaminabilities and large decontaminabilities. Microscopic observation (168 magnifications) indicated that coating surfaces were compact and ordered. Phenol resin paint and acryl resin paint gave comparatively good results. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Stars

8367 THE INFRARED SPECTRUM OF THE NML CYGNUS OBJECT. Johnson, H. L. (Univ. of Arizona, Tucson). Astrophys. J., 154: L125-9(Dec. 1968).

An infrared spectrum from 1.4 μ (7000 cm^{-1}) to 4.0 μ (2500 cm^{-1}) was obtained for the NML Cygnus infrared star. A rapid-scanning Michelson interferometer was used. The structure of the CO bands around 4300 cm^{-1} indicates a temperature of 2000 to 2500°K. As before, a large infrared excess, compared to those of giants of the same temperature, was found. A broad absorption at 3300 cm^{-1} (3.03 μ) was found; this absorption may be due to interstellar ice. (auth)

8368 PHOTOMETRIC EVIDENCE SUPPORTING THE REVISED CALIBRATION OF VEGA BY HAYES. Matsushima, Satoshi; Hall, David L. (Pennsylvania State Univ., University Park). Astrophys. J., 154: L147-51(Dec. 1968).

A comparison is made between the observed six-color magnitudes and the corresponding values computed from monochromatic-scanner observations that are calibrated on various photometric standards. The result indicates that the photometric standard based on the new calibration of Vega by Hayes produces the best agreement, while the earlier calibrations yield a systematic discrepancy amounting to more than 0.1 mag in V. (auth)

8369 PARTIAL MASER EFFECT IN THE RECOMBINATION RAYS OF HYDROGEN ATOMS IN A NEBULAR PLASMA. Hoang, Binh-dy (Observatoire de Paris-Meudon, France). Compt. Rend., Ser. A and B, 267: 739-40(Oct. 7, 1968). (In French).

Direct, differential, and semi-direct methods were applied to the resolution of the statistical equilibrium equations representing the populating and depopulating of an energy level. The three methods were reduced to the resolution of a finite system of linear equations. The semi-direct method gave the best results with fewer equations than either of the other two methods. (J.S.R.)

8370 ENERGY PRODUCTION IN STARS. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.). Naturwissenschaften, 55: 405-13 (Sept. 1968). (In German).

The Nobel lecture delivered by H. A. Bethe is presented. It reviews the most current theoretical and experimental results on the mechanisms for the energy production in stars. This historical development of solar studies are outlined. The properties of stars are summarized. The thermonuclear reactions and nuclear reactions in main-sequence stars are reviewed. The development of a star is described, and the synthesis and distribution of the elements are considered. 22 references. (J.S.R.)

8371 DEVELOPMENT OF THE CENTRAL STARS OF PLANETARY NEBULAE. Deinzer, Willi (Univ., Heidelberg. Univ. of Colorado, Boulder). Umsch. Wiss. Tech., 68: 724 (Nov. 7, 1968). (In German).

If a star contracts, gravitational energy is released. This energy partially goes to the internal energy of the star and the rest is radiated. If the energy balance is estimated, it is shown that in the contraction of the central star an energy contribution must be radiated that is an order of magnitude greater than that observed. Two possible mechanisms are proposed to explain the contraction. The first is that only a small part of the free energy is radiated in the form of photons; the largest part is radiated as neutrinos. According to the second mechanism it is assumed that a negligible part of the star mass is involved in the observed contraction. (J.S.R.)

8372 SPECTROPHOTOMETRY OF A B-TYPE STAR IN THE GLOBULAR CLUSTER M13. Stoeckly, Robert; Greenstein, Jesse L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 154: 909-22(Dec. 1968).

Barnard 29, a member of the cluster M13, is an early B-type star lying 3 mag above the horizontal branch. Spectrograms of the blue region at 38 and 18 Å mm^{-1} show an extremely sparse line spectrum. A coarse analysis of the spectrum indicates an ionization temperature of 19,700 ± 1500°K (θ_i = 0.256), an effective surface gravity log g_{eff} = 2.6, a radius of 3.4 ± 0.7 $R_\odot$, a luminosity of 2500 ± 1000 $L_\odot$, and a mass of 0.3 $M_\odot$, suggesting a highly evolved star. The He/H ratio seems close to that in Population I, unlike the surfaces of horizontal-branch stars. The logarithmic mean of the relative abundances of C, N, O, Mg, and Si (using upper limits for three elements not detected) shows them to be less abundant than in τ Sco and the Sun by a factor of at least 20. The carbon abundance is very low, ruling out the possibility that this star is the exposed core of a highly evolved red giant. The likeliest interpretation is that it is an old star of initial mass near 1.4 $M_\odot$, in which no nuclear reactions beyond the CNO bi-cycle have operated and from which 80% of the mass has somehow been removed to expose an only partially exhausted core. Photoelectric flux measurements show that the slope of the continuum is abnormally small compared with the Balmer jump, possibly indicating a double star containing a red subgiant companion. Seven measurements show variable radial velocity, also suggesting duplicity. (auth)

8373 SPECTROSCOPIC AND PHOTOMETRIC INVESTIGATION OF THE ASSOCIATION CEPHEUS OB2. Simonson III, S. Christian (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 154: 923-31(Dec. 1968).

Distance moduli based on MK spectral classification and UBV photometry were obtained for seventy-five intrinsically bright stars in the region of Cepheus OB2. A concentration of early-type main-sequence and supergiant stars with a mean distance modulus of 9.5 mag is found between l^{II} = 96 and 107°, b^{II} = +2 and +8°. The concentration includes the clusters NGC 7160 and Trumpler 37. A connection is seen with Cepheus OB3, and a concentration of about $1.5 \times 10^5 M_\odot$ of neutral hydrogen at the same radial velocity as the stars surrounds both associations. Little evidence was found to support a value of total absorption in V to selective absorption in B−V different from 3.0. (auth)

8374 STELLAR ROTATION AND Be STARS IN THE h AND χ PERSEI ASSOCIATION. Slettebak, Arne (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 154: 933-44(Dec. 1968).

Spectral types and rotational velocities were estimated for eighty-three stars in the vicinity of the double cluster in Perseus, with particular emphasis on the Be stars in the region. The mean rotational velocity for normal giant stars in the clusters (183 km sec^{-1}) is considerably higher than for field stars of corresponding type (116 km sec^{-1}), while the Be stars have the large mean rotational velocity (279 km sec^{-1}) characteristic of such objects. The Be stars associated with h and χ Persei appear to be located above the main sequence, which can be interpreted as due to evolution in addition to aspect effects of rotating stellar atmospheres. The existence of two kinds of Be stars, as suggested recently, is not supported by the present data. (auth)

8375 PHOTOMETRIC BEHAVIOR OF MAGNETIC STARS. Stepien, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 154: 945-70(Dec. 1968).

Detailed three-color observations of sixteen magnetic stars are presented, and a discussion of the photometric properties of twenty-three stars observed by the author is given. The results indicate that in virtually every case, if enough data are obtained, it is possible to find periodicities in the variations. Comparison with observations obtained by other investigators shows that there is no evidence for variability of periods, amplitudes, and shapes of light curves. It is shown that the extreme of the magnetic and light curves can be in phase as well as in antiphase. Two groups of magnetic stars are distinguished according to their photometric behavior: one consists of stars having V, B−V, and U−B variations in phase, and the other consists of stars having a double wave in V and a peculiar B−V curve with a broad, flat maximum. Variations of light in the first group can be explained in terms of variable effective temperature of a visible hemisphere. The results seem to support the hypothesis that the rotation is a main cause of variations of the magnetic stars. (auth)

8376 THE LIGHT, MAGNETIC, AND RADIAL-VELOCITY VARIATIONS OF HD 10783. Preston, George W.; Stepien, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 154: 971-4(Dec. 1968).

Concurrent UBV photometric and Zeeman spectroscopic observations of HD 10783 were used to improve the period found by Steinitz and to show that the light and magnetic maxima coincide in phase for this star. A small velocity variation lags approximately one-quarter cycle behind the light and magnetic variations. Comparison of radial velocities at three different epochs suggests that HD 10783 is a single-lined spectroscopic binary with a long period. (auth)

8377 THE EARLY A STARS. III. MODEL-ATMOSPHERE ABUNDANCE ANALYSIS OF FOUR FIELD STARS. Conti, Peter

S. (Univ. of California, Santa Cruz); Strom, Stephen E. Astrophys. J., 154: 975-82(Dec. 1968).

An abundance analysis of four extremely sharp-lined field A stars was made. The analysis uses a complete model-atmosphere approach to secure the abundance of each element. The results show that γ Gem, θ Vir, and HD 2421 have nearly identical element abundances which are the same as Vega, aside from the element barium. The other star, o Peg, has underabundant scandium and overabundant heavy elements, much like Sirius. o Peg is like Am stars in its composition. This model-atmosphere analysis confirms that early A stars showing a low ratio of Sc II λ4246 to Sr II λ4215 will also have other Am abundance characteristics. (auth)

8378 ANALYSIS OF SUBDWARF HD 25329. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 154: 983-6(Dec. 1968).

From an analysis of the profiles of Hα, $\lambda\lambda$5896 and 5890 of Na I, and λ5183 of Mg I, one obtains, for the subdwarf HD 25329 T_e = 4800°K and a hydrogen-to-metal ratio of 20 times the solar value, which is in good agreement with the curve-of-growth study of Pagel and Powell. (auth)

8379 SLOWLY ROTATING POLYTROPES. Kovetz, A. (Tel-Aviv Univ., Israel). Astrophys. J., 154: 999-1003(Dec. 1968).

The theory of slowly rotating polytropes (Chandrasekhar; Chandrasekhar and Lebovitz) is reviewed. Certain inconsistencies are removed, and previous numerical results are confirmed. (auth)

8380 STATISTICAL EQUILIBRIUM AND ERGODIC MARKOV CHAINS. Dietz, R. D. (Univ. of Hawaii, Honolulu). Astrophys. J., 154: 1159-61(Dec. 1968).

The time development of atomic-state populations may be described by an ergodic Markov chain. This leads to a concise solution of the time-dependent statistical-equilibrium equations. (auth)

8381 CHARTS FOR HYADES STARS. Johnson, H. L.; Mitchell, R. I.; Iriarte, B. (Univ. of Arizona, Tucson. Univ. Nacional de Mexico, Mexico City). Astrophys. J., 154: 1163-9(Dec. 1968).

Identification charts are presented for Hyades stars in the Pleiades cluster not previously identified. (W.D.M.)

8382 SPECTRAL CLASSIFICATION OF SOME A STARS WITH LARGE m_1 INDICES. Milton, Robert L.; Conti, Peter S. (Univ. of California, Santa Cruz). Astrophys. J., 154: 1147-50 (Dec. 1968).

A high-dispersion spectral study of eleven previously unclassified A stars with large Strömgren m_1 indices was made. All those with $m_1 > 0.230$ are metallic-line stars. (auth)

8383 SOME UNCERTAINTIES IN POPULATION-II STELLAR MODELS NEAR THE MAIN SEQUENCE. Demarque, Pierre; Hartwick, F. D. A.; Naylor, M. D. T. (Univ. of Chicago. Univ. of Toronto). Astrophys. J., 154: 1143-46(Dec. 1968).

Stellar models for Population-II stars near the main sequence, computed in several different ways, are compared. It is found that, although there are considerable uncertainties in the radii of such models, the bolometric magnitude is nearly constant for a given age, mass, and chemical composition. (auth)

8384 PRIMORDIAL HELIUM AND THE LUMINOSITY OF HORIZONTAL-BRANCH STARS. Asano, Naruyoshi; Sugimoto, Daiichiro (Nagoya Univ., Japan. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 154: 1127-33(Dec. 1968).

It is shown that the absolute magnitudes of the horizontal-branch stars and of the field RR Lyrae stars are observationally well correlated with their metal abundances. Theoretically, these stars are in the helium-burning phase. By studying models involving helium flash, theoretical luminosities of the stars in the helium-burning phase were determined for different abundances of helium and of metals. Comparison of the models with observation indicates that the helium concentration is as high as the value predicted by the theory of its origin by primordial synthesis. (auth)

8385 CALCULATED ELECTRON AND ION STARK BROADENING OF THE ALLOWED AND FORBIDDEN 2 ^{3}P–4 ^{3}P, ^{3}D, ^{3}F TRANSITIONS IN NEUTRAL HELIUM. Griem, Hans R. (Univ. of Maryland, College Park). Astrophys. J., 154: 1111-22(Dec. 1968).

Profiles of the line of He(I) at 4471.48 Å (2 ^{3}P–4 ^{3}D) inclusive of the forbidden component at 4470.04 Å (2 ^{3}P–4 ^{3}F) are derived, using the quasi-static approximation to account for the perturbing ions and the impact approximation as generalized for overlapping lines to describe the electron effects. The influence of the 4 ^{3}P level is considered as a further perturbation, but broadening of the 2 ^{3}P levels is neglected. Tabulated profiles of the line absorption coefficient are presented which, in addition to Stark broadening, allow for fine structure of the lower levels and thermal Doppler broadening. For low electron densities, asymptotic formulas are proposed, together with suitably weighted and displaced Doppler profiles. (auth)

8386 CALCULATED LINE STRENGTHS FOR THE TRANSITIONS BETWEEN THE CONFIGURATIONS ($3d^2 + 3d^24s$) AND $3d^24p$ IN Ti II. Mendlowitz, H. (Howard Univ., Washington, D. C. National Bureau of Standards, Washington, D. C.). Astrophys. J., 154: 1099-1110(Dec. 1968).

The relative line strengths in Ti(II) for the transitions between the configurations ($3d^3 + 3d^24s$) and $3d^24p$ were calculated. The strengths were calculated in the intermediate coupling scheme by taking into account the interaction between configurations. The relative magnitude and phase of the radial transition integrals (s–p) and (d–p) for the jumping electron in the LS-coupling scheme were obtained empirically from the data of King and those of Wobig by means of a least-squares fit to each set of data separately. From both sets of data the relative phase was determined to be –1, and the ratio of the magnitudes of the radial-integral parameters obtained from King's data differed from that obtained from Wobig's data by 10%. The calculated relative strengths were normalized to approximate the experimental absolute gf-values given by Wobig for a group of lines corresponding to the transitions of the $a^4P-z^4D^0$ multiplet. A comparison of the calculated and experimentally determined line strengths was made. An analysis of the data indicates that a number of the experimentally determined lines are obtained under optically thick conditions. (auth)

8387 SOME PROBLEMS CONCERNING THE He I LINES IN B TYPE SPECTRA. Underhill, Anne B. (Sonnenborgh Observatory, Utrecht). Bull. Astron. Inst. Czech., 19: 259-63 (1968).

Some predictions concerning the He I lines in B-type spectra are made using LTE theory and model atmospheres known to permit satisfactory prediction of the continuous spectrum of B stars. A relative abundance of helium to hydrogen of 0.118 was adopted. (W.D.M.)

8388 COLOR ANOMALIES AND METAL DEFICIENCIES IN SOLAR-TYPE DISK-POPULATION STARS. Conti, P. S. (Univ. of California, Santa Cruz); Deutsch, A. J. Bull. Astron. Inst. Czech., 19: 263-4(1968).

It has been pointed out previously (Conti, Deutsch 1966, 1967) that microturbulence in solar-type stars might be important enough to explain a good deal of the scatter in photometric indices previously attributable to small abundance differences. The purpose of this short note is to report on the results of a test of this suggestion. A comparison of curves of growth in two pairs of solar-type stars with similar color temperatures but very different m_1 indices was made. (W.D.M.)

8389 SOME PROBLEMS IN CONNECTION WITH HIGH DISPERSION SPECTRA OF CARBON STARS. Fujita, Y. (Tokyo Univ.). Bull. Astron. Inst. Czech., 19: 274-9(1968).

Some problems in connection with high dispersion spectra obtained by some Condé spectrographs attached to the 74-inch reflector of the Okayama Observatory are discussed. Two examples of echelle spectrograms are shown. (W.D.M.)

8390 STELLAR SPECTROPHOTOMETRY ABOVE THE ATMOSPHERE. Stecher, T. P. (Goddard Space Flight Center, Greenbelt, Md.). Bull. Astron. Inst. Czech., 19: 279(1968).

A 32 cm telescope with a 3-channel spectrophotometer was accurately pointed at a number of stars. Spectral scans with a resolution of 5 and 10 Å over the range λ1100 to λ4000 were obtained. Preliminary results are presented on α CMa, ϵ CMa, ξ Pup, η Ori, β Ori, and ξ Opi. (W.D.M.)

8391 ULTRAVIOLET OBJECTIVE-PRISM SPECTRA FROM GEMINI XI AND XII MANNED SPACE FLIGHTS. Henize, K. G.; Wray, J. D.; Wackerling, L. R. (Northwestern Univ., Evanston, Ill.). Bull. Astron. Inst. Czech., 19: 279-82(1968).

During the standup extra-vehicular activity periods of Gemini flights XI and XII the astronauts spent about 40 minutes during each flight obtaining objective-prism spectra of stars in the 2300 to 5000 Å region. The spectrograph consisted of a small camera with an ultraviolet lens to which was attached a quartz objective prism with a 10° wedge angle. Data are given on some stars in the Orion and Scorpius regions. (W.D.M.)

8392 A STUDY OF PLANETARY NEBULA NGC 1514. III. ISOPHOTIC CONTOURS AND THE SPATIAL MODEL OF THE NEBULA. Kohoutek, L. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 19: 285-91(1968).

On the basis of a study of isophotic contours of NGC 1514 in the photographic region an attempt to construct a spatial model of this planetary nebula was made. Two principal condensations, symmetrically distributed regarding the central star, were interpreted as projection of the toroid on the sphere — then the nebula can be classified as a type 3 object with the axis lying in the position angle 35°. The intensity distribution of the nebula as a function of the distance from the center was studied in the directions of the toroidal axis and equator. The best agreement with observations is given by the model of (a) the outer homogeneous spherical layer of 206″ in angular diameter, and (b) the inner part of the nebula with diameter of about 136″, which can be represented in the direction of the toroidal axis as a homogeneous sphere of constant density, and in the direction of the toroidal equator as two homogeneous concentric rings. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

8393 REDSHIFTS OF FIFTEEN RADIO SOURCES. Searle, Leonard (Australian National Univ., Canberra); Bolton, J. G. Astrophys. J., 154: L101-4(Dec. 1968).

Spectrograms of thirty-eight radio sources were obtained with the Carnegie image-tube spectrograph at the Cassegrain focus of the Mount Stromlo 74-inch reflector. Redshifts are given for fifteen emission-line objects, of which seven are quasi-stellar objects, three are N-type galaxies, and five are elliptical galaxies. (auth)

8394 REDSHIFTS OF TWELVE QUASI-STELLAR OBJECTS. Bolton, J. G. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales); Kinman, T. D.; Wall, J. V. Astrophys. J., 154: L105-8(Dec. 1968).

Redshifts were determined for twelve new quasi-stellar objects. Finding charts are given for eight whose identifications have not been previously published. Photoelectric magnitudes and colors are given for seven of the objects. (auth)

8395 SPECTROSCOPIC OBSERVATIONS OF TWENTY-FIVE QUASI-STELLAR OBJECTS. Burbidge, E. Margaret (Univ. of California, San Diego). Astrophys. J., 154: L109-15(Dec. 1968).

Spectroscopic observations of twenty-five blue stellar objects were made with the Lick 120-inch telescope. The objects are either known quasi-stellar objects or are suggested new identifications. Redshifts were determined for eighteen of these; four objects in which only one spectral feature is seen are also discussed, and further observations of three objects discussed earlier by Kinman and Burbidge are described. One earlier misidentification of a QSO is noted. (auth)

8396 IRON LINE EMISSION FROM X-RAY SOURCES. Holt, S. S.; Boldt, E. A.; Serlemitsos, P. J. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 154: L137-40 (Dec. 1968).

X-ray sources for which thermal models have been proposed should exhibit line structure for energies below 10 keV. The $(1s)^2-1s2p$ transition in Fe XXV at 6.64 keV is the emission line that is characteristically the most easily observable, and its absence in experimentally observed spectra is shown to constrain proposed thermal models severely. (auth)

8397 OPTICAL POLARIZATION OF STARS IN THE NEIGHBORHOOD OF CP 1919. Veverka, J.; Liller, W. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 154: L145-6(Dec. 1968).

Analysis of three plates taken June 23 and 24, 1968, at the f/7.5 Cassegrain focus of the 84-inch reflector at Kitt Peak indicated that the polarization of the blue star is $2 \pm 1\%$ at a position angle of $107 \pm 20°$, which is about average for stars in this field. From the results it is inferred that the distance to the blue star is 400 (±150) pc and its absolute magnitude is $+10 \pm 2$. It is tentatively concluded that the blue star is not related to CP 1919. (W.D.M.)

8398 PULSATING RADIO SOURCES NEAR THE CRAB NEBULA. Staelin, David H.; Reifenstein III, Edward C. (National Radio Astronomy Observatory, Charlottesville, Va.). Science, 162: 1481-3(Dec. 27, 1968).

Two new pulsating radio sources, designated NP 0527 and NP 0532, were found near the Crab Nebula and could be coincident with it. Both sources are sporadic, and no periodicities are evident. The pulse dispersions indicate that 1.58 ± 0.03 and $1.74 \pm 0.02 \times 10^{20}$ electrons/cm^2 lie in the direction of NP 0527 and NP 0532, respectively. (auth)

8399 A SUPERNOVA REMNANT IN CENTAURUS. Whiteoak, J. B.; Gardner, F. F. (CSIRO, Sydney). Astrophys. J., 154: 807-15(Dec. 1968).

A study was made of the distributions of polarization and intensity at 629, 1410, and 2650 MHz over an extended radio source located in Centaurus. The large angular size of the source (1.5°), its low galactic latitude (10°), and its relatively flat spectrum ($a = 0.5$) suggest that it is the remnant of a type II supernova explosion. The results are in accord with a theoretical model proposed by van der Laan in which the radio emission is due to the injection of high-energy electrons from the supernova debris into the region where the galactic magnetic field is compressed by the explosion. The implications of the derived orientation of the galactic magnetic field in the vicinity of the source are discussed. (auth)

8400 ONE-DIMENSIONAL POLARIZATION DISTRIBUTIONS OVER FOUR SUPERNOVA REMNANTS AT 1418 MHz. Seielstad, G. A.; Weiler, K. W. (California Inst. of Tech., Pasadena). Astrophys. J., 154: 817-32(Dec. 1968).

Distributions of the linearly polarized radiation at a frequency of 1418 MHz from the four supernova remnants 3C 10 (Tycho's supernova), Taurus A (Crab Nebula), 3C 358 (Kepler's supernova), and Cassiopeia A were determined by synthesizing a fan beam whose small dimension is along a circle of constant declination. In addition, extremely low upper limits were placed on the net degree of circular polarization in the integrated radiation from Tau A, 3C 358, and Cas A. For the latter two sources, no smaller circularly polarized regions within the source dimensions were found, using a resolution of better than 1′. Upper limits to the magnetic-field strengths, modified by geometrical factors were also calculated. The distributions in Tau A and Cas A were compared with those obtained at 1.55-cm wavelength by Mayer and Hollinger. (auth)

8401 OBSERVATIONS OF FOUR H II REGIONS AT A WAVELENGTH OF 2.8 CENTIMETERS. MacLeod, John M.; Doherty, Lorne H. (National Research Council, Ottawa). Astrophys. J., 154: 833-44(Dec. 1968).

Contour maps of the H II regions W12, Orion A, W43, and W51 are presented. These were derived from observations at 2.8 cm with a beam width of 2.8′. With this resolution, W12 consists of a single component, Orion A of two components, W43 of four components plus a large extended source, and W51 of eight components plus a large extended source. Flux densities and angular sizes of the components are listed, as are electron densities, emission measures, and masses. Identifications of the emission nebulae and the exciting stars are considered, and in the case of Orion A the data suggest that the main source is density-bounded on the north. The spectra of the sources are presented and discussed. It has previously been suggested that W51 contains a nonthermal source, but no evidence for this component was found. W51 and W43 are shown to have certain similarities in structure which may be related to their positions at tangential points of spiral arms. (auth)

8402 PHYSICAL CHARACTERISTICS OF SCO X-1. III. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J., 154: 1139-41(Dec. 1968).

It is shown that a black body of variable temperature above 4×10^4°K probably dominates in the optical spectrum of the x-ray source and accounts for the changes of magnitude and colors. (auth)

Solar Phenomena

Refer also to abstract 8484.

8403 REINTERPRETATION OF THE FEATURE AT 23.28 A IN SOLAR SOFT-X-RAY SPECTRA. Blake, Richard L.; House, Lewis L. (Univ. of Colorado, Boulder). Astrophys. J., 154: L141-3(Dec. 1968).

The feature at 23.28 Å observed in solar x-ray spectra and previously reported (Blake and House) as probably a Kα-type line of O III is actually an instrumental effect. Other lines, particularly λ1.91, suggested by Fritz et al., are still believed to be Kα-type lines. (auth)

8404 CHROMOSPHERIC SPECTRUM OUTSIDE OF ECLIPSE, λλ 3040 TO 9266 Å. Pierce, A. Keith (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 17: Suppl. Ser. No. 150, 1-370(Dec. 1968).

Approximately 11,500 chromospheric emission lines are listed from plates taken at the McMath solar telescope with the slit of the spectrograph placed tangent to the limb of the Sun. The ledger gives (1) solar wavelengths, (2) rough eye estimates of intensity, (3) identifications for both atomic and molecular lines, (4) laboratory wavelengths, and (5) multiplet numbers. A brief discussion of selected elements and lines is given in the text. (auth)

8405 INTENSITY OF THE SOLAR CONTINUUM AT λ = 20.15μ. ABSOLUTE MEASUREMENT OF THE BRILLANCE

TEMPERATURE OF THE CENTER OF THE DISC. Koutchmy, Serge; Peyturaux, Roger (CNRS, Paris). Compt. Rend., Ser. A and B, 267: 905-8(Oct. 21, 1968). (In French).

The brillance temperature of the solar disc was measured by comparison with a black body model in the medium infrared at $\lambda = 20.15\mu$ at Mont-Louis (Pyrenees-Orientales, 1600 m). For the first time it was possible to determine experimentally the intensity of the solar continuum in the vicinity of the minimum of the photosphere–chromosphere transition zone: $I_{(\lambda = 20.15\mu)}(0,0) = 2.13 \pm 0.05 \times 10^3$ (ergs · sec^{-1} · cm^{-3} · st^{-1}). (tr-auth)

8406 MAGNETOHYDRODYNAMIC MECHANISM OF THE SOLAR ACTIVITY. Dauvillier, Alexandre (Observatoire du Pic du Midi, Bagneres, France). Compt. Rend., Ser. A and B, 267: 840-5(Oct. 14, 1968). (In French).

It is shown how the differential rotation can be maintained by the delaying, at the resonance, of an oscillation of the photosphere on the rotation period by the effect of the planetary tides and how these modulate the activity according to the 11-year period; it is also shown how the toroidal field is concentrated and expelled from the photosphere by the eddies due to the Coriolis force. It is shown how this field is maintained by disruptive discharges constituting granulation. (tr-auth)

8407 TRANSPORT COEFFICIENTS IN THE CHROMOSPHERE AND CORONAL GAS. I. VISCOSITY. Delcroix, A.; Lemaire, J. (Institut d'Astrophysique, Cointe-Sclessin, Belgium). Astrophys. J., 154: 1155-7(Dec. 1968).

The viscosity coefficient for a monatomic ionized gas has been calculated in a first-order approximation by Chapman (1954). Scarf and Noble (1965) have estimated its value for a fully ionized mixture of 90% H and 10% He: they found that the value of η in this case is 69% of its value for a hydrogen plasma. In this note, more accurate values of η calculated in the second-order approximation are given for some chemical compositions typical for the solar corona and chromosphere. (W.D.M.)

8408 OSCILLATOR STRENGTHS OF THE RED AUTO-IONIZING LINES OF CALCIUM. Newsom, G. H. (Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 154: 1095-8(Dec. 1968).

A shock-tube experiment was designed to measure relative gf-values of the auto-ionizing lines of calcium near λ6360. Results from other experimenters for normal transitions were used to place the gf-values on an absolute scale, with an estimated error of 20%. The laboratory line strengths were compared with the observed line depths in the solar spectrum. (auth)

8409 ON THE GENERATION OF SYNCHROTRON AND X-RAY EMISSION FROM ELECTRONS WITH ENERGY BELOW mc^2 IN SOLAR FLARES. Holt, Stephen S.; Cline, Thomas L. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 154: 1027-38(Dec. 1968).

An attempt is made to reconcile a single source of electrons with both the hard x-ray and microwave radio emission observed at the peak of the solar flare of July 7, 1966. The spectral and temporal characteristics of the x-ray emission are used to determine the total number of electrons involved in the emission, as well as the shape of the generating electron spectrum. This is the first instance in which a generating electron spectrum has been directly inferred from experimental data. The spectrum is found to be $J(\gamma)d\gamma = A(\gamma - 1)^{-3}\, d\gamma$ or steeper, so that the bulk of the microwave emission originates from electrons with energies below mc^2. Both the observed x radiation and synchrotron radiation can be explained in terms of the same electron source if the source region is high in the chromosphere, where the maximum field may be as high as 1000 gauss. (auth)

8410 POLARIZATION OF EMISSION LINES IN ASTRONOMY. VI. OBSERVATIONS AND INTERPRETATIONS OF POLARIZATION IN GREEN AND RED CORONAL LINES DURING 1965 AND 1966 ECLIPSES OF THE SUN. Hyder, Charles L.; Mauter, Horst A.; Shutt, Robert L. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Astrophys. J., 154: 1039-58(Dec. 1968).

Observations of the polarization of the green and red coronal lines obtained during the 1965 and 1966 eclipses lead to the following results: the polarization results in the green line agree with those that one would expect theoretically from the conditions at eclipse, i.e., the degree of polarization in the green line varied between 2 and 25% in the range $1.0 \leq R/R_\odot \leq 1.5$, and the directions of polarization (electric vector) were approximately radial. These results substantiate the careful theoretical work done by Blaha on the cross section for electron collisional excitation of the green line and by Charvin on the polarization of the coronal green line. In order to clarify a severe contradiction between the polarization observations of others ($p_t \lesssim 83\%$) and the theoretical predictions ($p_t \equiv 0\%$) of the polarization in the red coronal line, the polarization of the red coronal line and of the adjacent coronal continuum during the eclipse of November 12, 1966 were observed and it was found that the average degree of polarization in the red coronal line was $2.0 \pm 3.5\%$. The results strongly support the theoretical predictions that the red coronal line cannot be polarized. Accurate measurements of polarization in the various coronal lines provide another dimension in the fixing of their identifications and in estimating the abundances of the parent ions. It is found, however, that the polarizing properties of observing instruments can introduce large systematic errors and that these errors must not be neglected as they have been in the past. (auth)

8411 INFRARED OBSERVATIONS OF THE OUTER SOLAR CORONA. MacQueen, R. M. (Johns Hopkins Univ., Baltimore). Astrophys. J., 154: 1059-76(Dec. 1968).

Observations of the outer solar corona at wavelength 2.2 μ were carried out in two experiments: during the period of totality of the solar eclipse of November 12, 1966, with the use of a ground-based telescope, and during a stratospheric balloon flight on January 9, 1967, by employing a coronagraph. The experiments are discussed, and the coronal radiance is presented over the range 3 to 10 $R_\odot$. The presence of four features is attributed to thermal emission of interplanetary dust. Scans obtained from the balloon experiment over a range of position angles show isophotes peaked away from the ecliptic at a position which closely coincides with the invariable plane. Attempts to assess the origin of the continuum radiance are presented and lead to calculations of a scattered infrared F-coronal component and a thermal component based upon large-particle cross sections. (auth)

8412 THEORETICAL UPPER BOUND TO THE SOLAR OBLATENESS. Goldreich, Peter; Schubert, Gerald (California Inst. of Tech., Pasadena. Univ. of California, Los Angeles). Astrophys. J., 154: 1005-10(Dec. 1968).

The stability of differentially rotating solar models was investigated earlier, and it was concluded that in regions of constant mean molecular weight the angular momentum per unit mass could not significantly decrease away from the rotation axis (in the absence of toroidal magnetic fields). In the current investigation it is shown that it is conceivable for sufficiently large gradients of rotational angular velocity to exist in the Sun's core to account for the solar oblateness which Dicke and Goldenberg claim to have measured. However, it is argued that it is more likely that turbulent mixing destroyed the gradients of mean molecular weight during the time when most of the Sun's angular momentum was lost and that, in reality, only very little angular momentum remains hidden in the solar interior. (auth)

8413 SOLAR AND GEOPHYSICAL EVENTS 1960–1965. (CALENDAR RECORD). Stickland, A. C. (ed.). Annals of the IQSY International Years of the Quiet Sun. Volume 2. Cambridge, Mass., Massachusetts Institute of Technology, 1968. 304p. $15.00.

The present volume contains the Calendar Record of the principal solar and geophysical events for the years immediately prior to and including the IQSY. (W.D.M.)

Galaxies

8414 ROCKET OBSERVATIONS OF BRIGHT CELESTIAL INFRARED SOURCES IN URSA MAJOR. Feldman, P. D. (Naval Research Lab., Washington, D. C. John Hopkins Univ., Baltimore); McNutt, D. P.; Shivanandan, K. Astrophys. J., 154: L131-6(Dec. 1968).

Several celestial sources in Ursa Major were detected in the spectral region 10 to 30 μ by a rocket-borne telescope. The typical flux is of the order of 4×10^{-14} W cm^{-2}. It appears that these sources are probably associated with galaxies and have luminosities comparable with optical luminosities of quasi-stellar sources. (auth)

8415 AN UPPER LIMIT TO THE ANGULAR DIAMETER OF THE NUCLEUS OF NGC 4151. Danielson, R.; Savage, B. D.; Schwarzschild, M. (Princeton Univ., N. J.). Astrophys. J., 154: L117-20(Dec. 1968).

From an analysis of images of the nucleus of the Seyfert galaxy NGC 4151 obtained during a recent flight of Stratoscope II, a 36-inch balloon-borne telescope, it is concluded that a safe upper limit to the half-intensity angular diameter of the nucleus is 0".18. This diameter, which refers to the nonthermal continuum, is several times as small as the lower limit to the half-intensity diameter of the region giving rise to the emission lines. (auth)

8416 ON THE FORMATION OF GALAXIES BY FRAGMENTATION. Sersic, J. L. (Observatorio Astronomico, Cordoba, Argentina). Bull. Astron. Inst. Czech., 19: 105-10(1968).

Observational evidence for the existence of two kinds of elliptical galaxies is discussed. The distribution of galaxies in the mass–radius diagram is interpreted as the result of fragmentation of elliptical galaxies of large mass. A model describing the gross properties of galaxies resulting from explosive events is developed and shown to be in fairly good agreement with observations. The properties of unstable groups of galaxies and clusters are also discussed. (auth)

8417 THE DISTRIBUTION OF NEUTRAL HYDROGEN AND THE KINEMATIC PROPERTIES OF NGC 6946. Gordon, Kurtiss J.; Remage, Nancy H.; Roberts, Morton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 154: 845-56(Dec. 1968).

The neutral-hydrogen content of the late-type spiral NGC 6946 was obtained from 21-cm line measurements made with the 300-foot telescope. The gross distribution of the hydrogen, as well as the rotation curve for this system, was derived by means of a model-generating program. In this approach a simple but reasonable model galaxy, described by fifteen parameters, was convolved with an antenna beam and a set of velocity filters. The resultant model drift curves were compared with the observed drift curves. The model giving the best fit to the observed data was adopted as representative of the actual system. The total mass was $2.3 \times 10^{11}\ \mathcal{M}_\odot$. This value is particularly sensitive to the adopted inclination because of the nearly face-on aspect of NGC 6946. The hydrogen distribution was approximated best by a ring whose radius is approximately twice that defined by the prominent spiral-arm features. The mass of neutral atomic hydrogen is $3.9 \times 10^9\ \mathcal{M}_\odot$. Parameters of the final model are listed, integral properties of this system are given. (auth)

8418 THE ROTATION AND MASS OF NGC 1832. Burbridge, E. Margaret; Burbridge, G. R. (Univ. of California, San Diego). Astrophys. J., 154: 857-61(Dec. 1968).

The rotation of the Sb galaxy NGC 1832 was measured. The rotation curve was analyzed to obtain the mass of the galaxy. For a distance of 25.3 Mpc it was found that the mass out to a distance of about 4.7 kpc from the nucleus is $3.5 \times 10^{10}\ \mathcal{M}_\odot$ and the mass-to-light ratio is 2.9 (solar units). The central density is about 10^{-21} g cm^{-3}, and mean density is 5.8×10^{-23} g cm^{-3}. No evidence for departures from circular motion was found. (auth)

8419 FLOW OF GAS FROM THE GALACTIC CENTER. Moore, D. W. (Goddard Inst. for Space Studies, New York); Spiegel, E. A. Astrophys. J., 154: 863-74(Dec. 1968).

A steady axisymmetric flow out of the galactic center is considered, neglecting magnetic and turbulent stresses and the self-gravitation of the gas. The flow is in a disk and possesses angular momentum, but otherwise the problem is like solar-wind theory, and it is assumed that initial conditions are specified at the edge of the nuclear disk. The equations of motion are then quite simple, and their solution indicates that the flow must contain a nearly discontinuous transition from supersonic to subsonic conditions. It is argued that this transition must be a compressible hydraulic jump, or bore, which generates intense turbulence and gives rise to H II on the downstream edge of the bore. The bore causes radial deceleration of the gas and hence density enhancement, and it is suggested that this phenomenon is associated with the expanding arm. (auth)

8420 THE DYNAMICAL STATE OF THE INTERSTELLAR GAS AND FIELDS. VII. DISRUPTIVE FORCES. Parker, E. N. (Univ. of Chicago). Astrophys. J., 154: 875-9(Dec. 1968).

The important role played by disruptive forces in regulating the conversion of interstellar gas into stars is pointed out in the context of the present dynamical theory of the interstellar gas and fields. (auth)

8421 OBSERVATIONAL EVIDENCE FOR THE EXISTENCE OF DENSE CLOUDS OF INTERSTELLAR MOLECULAR HYDROGEN. Werner, Michael W.; Harwit, Martin (Cornell Univ., Ithaca, N. Y. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 154: 881-9(Dec. 1968).

A faint emission feature was observed which is interpreted as evidence for the existence of substantial amounts of molecular hydrogen in a dark cloud in Orion. Essentially all the hydrogen present seems to be in the molecular form. The number of molecules along the line of sight through the cloud is $\gtrsim 10^{21}$ cm^{-2}, and the volume density is in the range $n_{H_2} \approx 10^3$ to 10^4 cm^{-3}. An alternate interpretation of the feature is discussed. (auth)

Cosmology

8422 (ISS-68/15, pp 22-5) 3^0K RADIATION AND COSMOLOGY. Chiuderi, C. (Florence Univ. (Italy). Istituto di Fisica). (In Italian).

The diffuse radiation in all the Universe that is characterized by its isotropy and its spectrum which agrees with that of a blackbody at a temperature of about 3°K is one factor that has led to increased interest in cosmological problems. A simple and coherent interpretation of the data obtained on this radiation is found within the framework of the evolutive-type relativistic cosmological models. Such a model is outlined. (J.S.R.)

8423 DEAD GALAXIES? Peebles, P. J. E. (California Inst. of Tech., Pasadena). Astrophys. J., 154: L121-3(Dec. 1968).

It is suggested that the system of absorption redshifts in the quasi-stellar source PKS 0237–23 might be due to the presence of dead galaxies numerous enough to fit a cosmologically flat model of the Universe. (auth)

8424 ORIGIN OF THE GLOBULAR STAR CLUSTERS. Peebles, P. J. E.; Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). Astrophys. J., 154: 891-908(Dec. 1968).

It is argued that the globular clusters may have originated as gravitationally bound gas clouds before the galaxies formed. This idea follows from the primeval-fireball picture, which suggests that the first bound systems to have formed in the expanding Universe were gas clouds with mass and shape quite similar to the globular star clusters. A picture is also presented for the evolution from these assumed proto-globular gas clouds to globular star clusters. (auth)

8425 ORIGIN OF COSMIC RADIATION AND THE EXPANSION OF THE UNIVERSE. Bagge, Erich. Theimig-Paperbacks. Volume 31. Munich, Verlag Karl Thiemig KG, 1968. 62p. DM 9.80; US $2.50.

An attempt is made to connect the acceleration of cosmic radiation to the expansion of the Universe. Topics discussed include the expansion of the cosmos, Newtonian cosmology, electric charge of cosmic matter, electron affinity of cosmic dust, deceleration of charged particles within the galactic plasma, negative electric charging of the galactic center by cosmic dust, expansion of the Universe as an electrically induced phenomenon, galactic magnetic fields as the result of the motion of the galactic charges, primary components of cosmic radiation, origin of the power spectrum of the cosmic primary particles in the electric field of the Milky Way, and the metagalactic field. (W.D.M.)

8426 PRESENT TEMPERATURE OF PRIMORDIAL BLACK-BODY GRAVITATIONAL RADIATION. Matzner, Richard A. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen. Univ. of Maryland, College Park). Astrophys. J., 154: 1123-6(Dec. 1968).

Simple considerations of the very early evolution of the Universe give an upper bound for the temperature of primordial gravitational radiation: T_g (now) $\lesssim 1.6$°K. (auth)

8427 STABILITY OF CONTINUALLY-CREATED MASS AGAINST GRAVITATIONAL DECAY. Liboff, Richard L. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 154: 1135-8(Dec. 1968).

In the steady-state Universe of Bondi and Gold (1948) matter is continuously created at the rate of 10^{-48} g/cm^3/sec. Hoyle (1948, 1949) is able to come to a similar conclusion by modifying the field equations of general relativity. Both theories yield an expanding Universe in which the density of matter remains constant. In the former theory, matter is not conserved. More generally, in Hoyle's formulation, the stress-energy tensor is no longer divergenceless, and again energy (mass) is not conserved. These theories yield a local creation of mass which in turn raises the question of the consistency of such theories with the principle of causality. In this paper the point of view is taken that the "static" field which accompanies such a mass is initiated with the creation of that mass and propagates away from it at the speed of light. It is presumed that the mass is the source of the propagating field energy. These statements of causality and energy conservation give rise to a self-consistent integral equation for the mass. (W.D.M.)

8428 OBSERVABLE HORIZONS IN THE EXPANDING UNIVERSE. Sato, Humitaka (Kyoto Univ.). Progr. Theor. Phys., (Kyoto), 40: 781-95(Oct. 1968).

Considering the absorption of extragalactic radiation in an expanding medium, observable limits of distances, i.e. observable horizons were investigated. For each of various radiations, the Universe was cloudy in the early stage filled with a dense absorbing medium, and it was thereafter cleared up at some critical time t_c. Photons emitted to t_c suffer reddening, being expressed in terms of red-shift parameter z; $z + 1 = 10^{1.6}$ to $10^{3.1}$ for γ rays, $10^{0.9}$ to $10^{2.3}$ for x rays and $10^{0.9}$ to 10^3 for thermal photons corresponding to the Friedmann Universe model with the present matter density $\rho_{m0} = 10^{-29}$ to 10^{-32} g/cm^3. As the cosmic blackbody radiation is a relict radiation emitted from matter at the observable horizon, it may carry information on the structure in the early period of 10^6 to 10^7 years since the birth of the Universe. From this point, an inhomogeneous distribution of this radiation

with the angular size of 10′ to 1″ is likely to take place concerning galaxy formation. (auth)

8429 ANISOTROPY OF THE EARLY STAGES OF COSMOLOGICAL EXPANSION AND OBSERVATION. Grishchuk, L. P.; Doroshkevich, A. G.; Novkiov, I. D. (State Astronomical Inst., Moscow. Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2281-90(Dec. 1968). (In Russian).

If the early stages of cosmological expansion differ from the Friedmann homogeneous isotropic model then the most general of all laws would be the law of variation of volume element of matter with time. It is shown that there exist homogeneous anisotropic cosmological models with expansion law (1) for $t \to 0$ and which tend to the Friedmann expansion pattern for any observer when $t \to \infty$. Conditions of thermodynamic equilibrium at early stages of cosmological expansion when law (1) is valid are examined. The nature of anisotropy of relict cosmological radiation at later stages of expansion is investigated. It is shown that under present conditions the nature of anisotropy may be complex. The radiation may have an almost constant temperature over all the sky excluding a spot which size depends on the parameters of the model. Within the spot ΔT may have a certain sign or may change sign. (auth)

8430 POINCARE RECURRENCE THEOREM AND PROBLEM OF GRAVITATIONAL COLLAPSE. Gurovich, V. Ts.; Fridman, A. M. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 55: 2227-9(Dec. 1968). (In Russian).

It is shown that the Poincare recurrence theorem is valid for a collapsing gravitational system if the velocity spread of the particles of the system is not zero. This signifies time reversal of the collapse (in a synchronous reference system). For zero velocity spread (Tolman solution) the Poincare theorem is inapplicable. The results are extended to the cosmological model of the Universe which, for the indicated initial conditions, turns out to be a pulsating one. (auth)

Planetary Phenomena

8431 MEASUREMENTS OF VENUS AND JUPITER NEAR 1-CM WAVELENGTH. Law, Sara E.; Staelin, David H. (Massachusetts Inst. of Tech, Cambridge). Astrophys. J., 154: 1077-86 (Dec. 1968).

Observations of Venus and Jupiter were made from January to March, 1966. The wavelengths were 1.18, 1.28, 1.35, 1.43, and 1.58 cm. The average brightness temperatures of Venus were 400, 418, 436, 451, and 477°K, respectively, and those of Jupiter were 120, 120, 107, 112, and 136°K, respectively. These spectra are compared with various atmospheric models. The observations of Venus permit an upper limit to be placed on water-vapor abundance. The measured brightness temperatures of Jupiter are approximately 1.5 standard deviations less than theoretical spectra. (auth)

8432 ROTATIONAL RAMAN SCATTERING IN PLANETARY ATMOSPHERES. Brinkmann, R. T. (California Inst. of Tech., Pasadena). Astrophys. J., 154: 1087-93(Dec. 1968).

When spectra of deep solar Fraunhofer lines recorded in sunlight scattered by the Earth's atmosphere are compared with similar spectra of direct, unscattered sunlight, it is found that the scattered line profiles are systematically less deep (relative to the continuum) than the direct profiles by a few per cent. This has been taken to indicate the presence of an extra, inelastic component of the scattered radiation field. Its nature has remained unexplained. In this paper it is pointed out that rotational Raman scattering in the atmosphere can be expected to produce just such an extra component. Previous observational work is reviewed and interpreted in light of this explanation. The magnitude of the effect in the atmospheres of other planets is also briefly explored. (auth)

Atomic and Molecular Physics

Refer also to abstracts 7741, 8380, 8386, 8408, 8684, and 8940.

8433 (CEA-R-3627) MULTIPLE COMPTON SCATTERING OF PHOTONS BY A TENUOUS GAS OF FREE ELECTRONS: SOME ASTROPHYSICAL IMPLICATIONS. Rouvillois, Gildas; Babuel Peyrissac, Jean-Paul (Commissariat a l'Energie Atomique, Vaujours (France). Centre d'Etudes). Oct. 1968. 16p. (In French). Dep.

The action of the black-body radiation emitted by a hot spherical source upon a low-density electron gas is studied. The binary collision model is used for the electron–photon scattering (Compton scattering) i.e., a restriction was made to physical situations in which the source temperature is high enough, or the electron density low enough for the effective photon wave lengths to remain much smaller than the average interelectronic distance. (auth)

8434 (CEA-R-3628) EXPERIMENTAL AND THEORETICAL STUDY OF YIELD AND SPECTRUM OF PHOTONS OBTAINED FROM POSITRON ANNIHILATION IN FLIGHT. Audit, Gerard; de Botton, Nico; Le Poittevin, Gerard; Schuhl, Claude; Tamas, Gabriel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1968. 21p. (In French). Dep.

A computer program has been used to calculate the spectrum of photons obtained from positron annihilation in flight; the calculation takes account of multiple scattering and energy loss of positrons in the annihilation target. Results are presented in the energy range 150 to 450 MeV which is the one of Saclay Linear Accelerator. As a check, results of the calculation are compared with measurements carried out at the Saclay Linac of 45 MeV. (auth)

8435 (NP–17708) SURFACE AND VACUUM PHYSICS INDEX. Volume 3, No. 9 (1178–1445). Bibliography; Author Index; Subject Index; List of Keywords. Hilsenbeck, D. (ed.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 113p. Dep.

267 papers relative to the title subjects are listed. (M.O.W.)

8436 OSCILLATOR STRENGTHS OF Eu I SPECTRAL LINES. Komarovskii, V. A.; Penkin, N. P.; Shabanova, L. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 81-2(July 1968).

Translated from Opt. Spektrosk., 25: 155-8(July 1968).

The Rozhdestvenskii hook method was used to determine the oscillator strengths (f values) of 49 lines of Eu I resulting from transitions from the ground state to excited levels. Relative and absolute f values and probabilities for the corresponding transitions calculated from the absolute f values are tabulated. (A.G.W.)

8437 DETECTION OF VIBRATIONALLY EXCITED N_2 BY SUPERELASTIC ELECTRON IMPACT. Burrow, P. D.; Davidovits, Paul (Yale Univ., New Haven). Phys. Rev. Lett., 21: 1789-91 (Dec. 30, 1968).

Electrons were scattered superelastically from nitrogen molecules vibrationally excited by quenching collisions with optically excited rubidium atoms. Analysis of the energy gained by the electrons shows that in more than 10% of the quenching collisions the highest energetically allowed vibrational state of N_2, $v = 5$, is populated. The relative superelastic cross section for collisions between molecules in this state and electrons is measured and compared with that predicted by detailed balance. (auth)

8438 ION–MOLECULE REACTIONS OF C^+ WITH N_2 AND O_2. Lao, R. C. C.; Rozett, R. W.; Koski, W. S. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 49: 4202-9(Nov. 1, 1968).

A tandem mass spectrometer was used to study the reactions $C^+ + X_2 \rightarrow X_2^+ + C$, $C^+ + X_2 \rightarrow X + X^+ + C$, and $C^+ + X_2 \rightarrow CX^+ + C$, where X is either nitrogen or oxygen, in the ion-energy range 5 to 200 eV. By studying the attenuation of the C^+ ion beam as a function of N_2 pressure at various electron energies, and by measuring the ion–molecule reaction cross sections at different electron energies, it was possible to estimate the contribution of the ^2P and ^4P states of C^+ to the reactions. (auth)

8439 CORRELATION OF EXPERIMENTAL RATE CONSTANTS OF THE HYDROGEN EXCHANGE REACTIONS WITH A THEORETICAL H_3 POTENTIAL SURFACE, USING TRANSITION-STATE THEORY. Shavitt, Isaiah (Battelle Memorial Inst., Columbus, Ohio. Ohio State Univ., Columbus). J. Chem. Phys., 49: 4048-56(Nov. 1, 1968).

The recent ab initio potential surface for H_3 obtained by Shavitt, Stevens, Minn, and Karplus is used with one empirical parameter, a uniform scale factor for the energy profile along the reaction path, to compute rate constants for various isotopic forms of the $H + H_2$ exchange reaction. The scale factor is adjusted to give agreement with the high-temperature part of the experimental rates recently measured by Westenberg and de Haas, and the results are compared with all the available experimental data. Tunneling is estimated by fitting a one-dimensional Eckart barrier to the higher 30% of the computed reaction-path barrier. It is concluded that the ab initio barrier needs to be scaled down by only 11% in order to reproduce the best experimental data, and the "experimental" barrier height is accordingly obtained as 9.8 ± 0.2 kcal/mole. (auth)

8440 POSSIBILITIES FOR THE CALCULATION OF HYDROGEN IONIZATION CROSS SECTIONS BY THE MONTE CARLO METHOD. Salmona, Albert; Stern, Bernard (Observatoire de Paris-Meudon, France). Compt. Rend., Ser. A and B, 267: 686-8(Oct. 7, 1968). (In French).

The Monte Carlo method was applied with success by Abrines and Percival in the case of the ionization of the hydrogen atom by a proton or an electron. The hydrogen was in the ground state. It is shown how this method can be extended to the excited states of hydrogen or even to hydrogenoids. (tr-auth)

8441 ABSOLUTE MEASUREMENT OF THE LIFE TIME OF THE 4p $^4S^0_{3/2}$ LEVEL OF ARGON II BY THE METHOD OF CORRELATION OF PHOTONS EMITTED IN CASCADE. Camhy-Val, Claude; DuMont, Anne-Marie (Institut d'Astrophysique, Paris). Compt. Rend., Ser. A and B, 267: 689-91(Oct. 7, 1968). (In French).

This method for the measurement of the lifetimes of excited states consists in the determination of the time interval which separates the emission of two photons correlated with an atom which is de-excited in cascade, using an electronic device having a time–amplitude converter connected to a multichannel amplitude selector. The experimental setup and the analysis methods used are briefly described. The results obtained are in good agreement with theoretical estimations. (tr-auth)

8442 PRODUCTION OF CARBON CHARACTERISTIC X RAYS BY HEAVY-ION BOMBARDMENT. Der, R. C.; Kavanagh, T. M.; Khan, J. M.; Curry, B. P.; Fortner, R. J. (Univ. of California, Livermore). Phys. Rev. Lett., 21: 1731-2(Dec. 23, 1968).

Cross sections for carbon K x-ray production have been measured for the ions H^+, He^+, C^+, N^+, O^+, Ne^+, Ar^+, Kr^+, and Xe^+ incident on a carbon target at energies 20 to 80 keV. The cross sections for the heavy ions are several orders of magnitude larger than those predicted by direct scattering theory and are interpreted in terms of the electron-promotion mechanism of molecular orbital theory. (auth)

8443 MONOENERGETIC PHOTON BEAMS BY POSITRON ANNIHILATION IN FLIGHT, BETWEEN 80 AND 300 MeV. Mancini, E.; Sanzone, M. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nucl. Instrum. Methods, 66: 87-92(Dec. 1, 1968).

The photon spectra from positron annihilation in hydrogen for different angles were calculated between 100 and 300 MeV. A particular beam-handling system for the positrons to improve the photon resolution was also proposed. (auth)

8444 VACUUM POLARIZATION IN MUONIC ATOMS. Fricke, B. (Univ., Frankfurt am Main). Z. Phys., 218: 495-508(1969). (In German).

The various approximations of vacuum polarization potential and the higher order corrections up to α^3 are reviewed and quantitatively discussed. The quadrupole part of the vacuum polarization is established. It leads rather straight forward to a small contribution of vacuum polarization to nuclear polarization. These effects are quantitatively investigated. (auth)

8445 PROPER CHOICE OF FINAL-STATE WAVE FUNCTION FOR DISSOCIATION AND ITS EFFECT ON THE ANGULAR DISTRIBUTION OF DISSOCIATION FRAGMENTS. Green, Thomas A.; Peek, James M. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev. Lett., 21: 1732-5(Dec. 23, 1968).

The collisional dissociation of a homopolar diatomic molecule has been heretofore described in terms of a transition to the vibrational continuum of a single Born–Oppenheimer electronic state. This choice of final state, which is shown to be incorrect, yields dissociation-fragment angular distributions symmetric about an angle of 90° with respect to the beam. The proper final state yields angular distributions that need not possess this symmetry. (auth)

8446 EXPERIMENTAL ESTIMATE OF THE OSCILLATOR STRENGTH OF THE $^2S_{1/2} \rightarrow {}^2P_{3/2,\,1/2}$ TRANSITION OF THE HYDROGEN ATOM. Barker, John R.; Michael, J. V. (Carnegie-Mellon Univ., Pittsburgh). J. Opt. Soc. Amer., 58: 1615-20(Dec. 1968).

The oscillator strength of the Lyman-α transition in the hydrogen atom has been determined by the line-absorption method. Hydrogen atoms were produced in a fast-flow system by a microwave discharge in a H_2–He mixture. The hydrogen atoms absorbed the Lyman-α radiation at 1216 Å emitted by a hydrogen–neon lamp, and absolute atom concentration was determined by titration with NO_2. On the basis of the photometric calibration curve determined in this way, oscillator strengths were calculated as a function of assumed emission-line profiles. The best fit to the experimental data yielded an oscillator strength of 1.09 ± 0.27. (auth)

8447 MEASUREMENT OF THE TOTAL CROSS SECTION FOR SYMMETRIC CHARGE EXCHANGE IN HELIUM FROM 400 TO 2000 eV. Nagy, Stephen W.; Savola, William J. Jr.; Pollack, Edward (Univ. of Connecticut, Storrs). Phys. Rev., 177: 71-6(Jan. 5, 1969).

The energy dependence of the total cross section for symmetric charge exchange in helium is measured in the range from 400 to 2000 eV. Beam-attenuation techniques are used, and all measurements are made on the forward-scattered ions and the high-energy neutrals resulting from the charge exchange. Cross-section values are given at 100-eV intervals, and the results show a cross section decreasing as the energy increases, with a value at 1000 eV of 1.04×10^{-15} cm^2. The absolute cross sections are accurate to ±12%. Relative cross-section values accurate to ±6% are reported. (auth)

8448 GROUP R_4 IN ATOMIC-STRUCTURE THEORY: THE HYDROGENIC R_4 VERSUS THE MATHEMATICAL R_4 AND THE COULOMB INTERACTION IN $2s^m2p^n$ AND $3s^m3p^n3d^r$ CONFIGURATIONS. Alper, Joseph S.; Sinanoglu, Oktay (Yale Univ., New Haven). Phys. Rev., 177: 77-85(Jan. 5, 1969).

The rotation group in four dimensions R_4 is applied to the study of the $2s^m2p^n$ configurations of atoms. This Lie group is used in both the mathematical sense, describing the transformation properties of the angular parts of the 2s and 2p electrons, and in the more physical sense of an approximate symmetry group for the first-row atoms. The various states of each configuration are classified by means of R_4. By expressing the Coulomb interaction in terms of tensors transforming according to irreducible representations of R_4, Coulomb and exchange integrals are evaluated group theoretically. The method is extended to $3s^m3p^n3d^r$ configurations. The states are classified by means of R_4 and Coulomb and exchange integrals are approximately evaluated. (auth)

8449 APPLICATION OF THE GROUP R_4 TO ENERGY-LEVEL SEPARATIONS AND THE EVALUATION OF CORRELATION ENERGY IN ATOMS. Alper, Joseph S. (Yale Univ., New Haven). Phys. Rev., 177: 86-93(Jan. 5, 1969).

The group R_4 is applied to the study of energy-level separations and correlation energies in the ground-state configurations of first-row atoms. The separation between two nearly degenerate levels, e.g., $2s^2\ {}^1S$ and $2p^2\ {}^1S$ for which only the $\Sigma_{i>j} 1/r_{ij}$ part of the Hamiltonian is considered, can then be determined by means of group theory. This eliminates the need of solving the secular equation arising from the usual configuration-interaction procedure. Extending this work to the one-electron part of the Hamiltonian allows estimation of the actual splittings and the $\epsilon(2s^2)$ nondynamical (near degeneracy) correlation energy for the first-row atoms. The Z and N dependence of this type of correlation is seen to be closely related to the group theoretical treatment. Finally this method is extended to a treatment of the nondynamical correlation in second-row atoms. (auth)

8450 ATOMIC-BEAM MEASUREMENT OF ISOTOPE SHIFTS IN THE D_1 LINE OF ^{127}Cs, ^{129}Cs, ^{133}Cs, $^{134\,m}$Cs, ^{134}Cs, AND ^{137}Cs. Marrus, Richard; Wang, Edmond C.; Yellin, Joseph (Univ. of California, Berkeley). Phys. Rev., 177: 122-6(Jan. 5, 1969). (UCRL-18434).

The atomic-beam method has been applied to the measurement of isotope shifts in the D_1 line of five radioactive isotopes including the isomeric pair ^{134}Cs–$^{134\,m}$Cs. The shifts in these lines, relative to the energy in the D_1 line of ^{133}Cs are as follows: ^{127}Cs, +5.9(1.5) mK; ^{129}Cs, +2.8(1.5) mK; ^{134}Cs, +1.8(1.0) mK; ^{134m}Cs, −2.2(1.2) mK; and ^{137}Cs, −6.0(1.5) mK. Here a positive sign means that the frequency of the D_1 line for the indicated isotope is greater than that for ^{133}Cs. Evidence that the observed shifts arise almost completely from nuclear effects is presented. These shifts must therefore be compared with a calculated shift arising from the normal volume effect of 10 mK/neutron. (auth)

8451 NUCLEAR-POLARIZATION CORRECTIONS TO THE LEVELS OF MUONIC ATOMS. Cole, R. K. Jr. (Stanford Univ., Calif.). Phys. Rev., 177: 164-83(Jan. 5, 1969).

It is shown that information about the nuclear electromagnetic-transition vertex derived from experimental inelastic-scattering cross sections for electrons may be used to evaluate the nuclear-polarization (dispersion) corrections to the levels of muonic atoms. A model-independent result is obtained for the contributions of discrete nuclear states. The most important systematic features of nuclear-excitation spectra, the giant-dipole resonance and the quasielastic peak, are considered in detail. The Goldhaber-Teller model is used for the former, and a simple-harmonic-oscillator shell model for the latter. Numerical estimates are obtained for total level shifts of low-lying muon states in nuclei with closed (harmonic-oscillator) proton shells, using closure approximation for the muon. The muon closure energies are considered in detail. The results obtained are probably accurate to a factor of 2. The shifts are estimated to be several keV for the 1s state in heavy nuclei, and somewhat less (a few tenths to about 1 keV) for the 2s and 2p states. These shifts are significant in comparison to the present accuracy of measurement of muonic x-ray spectra, and should be considered in calculations to fit nuclear-charge distributions. (auth)

8452 CHARGE-EXCHANGE COLLISIONS BETWEEN HYDROGEN IONS AND CESIUM VAPOR IN THE ENERGY RANGE 0.5 TO 20 keV. Schlachter, A. S.; Bjorkholm, P. J.; Loyd, D. H.; Anderson, L. W.; Haeberli, W. (Univ. of Wisconsin, Madison). Phys. Rev., 177: 184-90(Jan. 5, 1969).

Charge-exchange collisions have been studied when H^+ ions and

ground state H^0 atoms are incident on Cs vapor. Measurements of the positive, neutral, and negative beam components after passage through the target were made as a function of the Cs target thickness at several energies between 0.5 and 20 keV. All three beam components were found to approach charge equilibrium monotonically. The maximum H^- equilibrium yield is (21 ± 4)%, which occurs at an H^+ energy of 0.75 keV. The H^- yield decreases with increasing energy, and is 0.4% at 20 keV. At energies below 4 keV the H^+ equilibrium yield is very small compared with the yield of H^0 and H^-. For energies greater than 10 keV the H^- equilibrium yield is very small compared with the yield of H^0 and H^+. The cross sections σ_{+0}, σ_{+-}, σ_{0+}, and σ_{0-} were measured. The subscripts + and − refer to the H^+ and H^- ions, 0 as an initial subscript refers to a ground-state H^0 atom, and 0 as a final subscript refers to an H^0 atom in the particular states produced. The cross section σ_{+0} decreases with increasing energy, and ranges from $(9.4 \pm 2.0) \times 10^{-15}$ cm^2 at 1 keV to $(7.5 \pm 1.1) \times 10^{-16}$ cm^2 at 15 keV. The cross section σ_{+-} decreases with increasing energy in the range 2 to 15 keV, and has the value $(2.1 \pm 0.6) \times 10^{-17}$ cm^2 at 5 keV. The cross section σ_{0+} increases with increasing energy, having the value $(1.2 \pm 0.2) \times 10^{-17}$ cm^2 at 2 keV, and $(1.74 \pm 0.26) \times 10^{-16}$ cm^2 at 15 keV. The cross section σ_{0-} decreases with increasing energy, having the value $(1.5 \pm 0.3) \times 10^{-16}$ cm^2 at 2 keV and $(1.4 \pm 0.2) \times 10^{-17}$ cm^2 at 15 keV. (auth)

8453 DOUBLE-ELECTRON-CAPTURE CROSS SECTIONS FOR INCIDENT PROTONS IN THE ENERGY RANGE 75 TO 250 keV. Toburen, L. H.; Nakai, M. Y. (Oak Ridge National Lab., Tenn.). Phys. Rev., 177: 191-6(Jan. 5, 1969).

The double-electron-capture cross sections were measured for protons in the energy range from 75 to 250 keV incident upon the target gases H_2, He, Ar, Kr, N_2, and H_2O. A power-law extrapolation of the present results for H_2 and He joins smoothly with previously measured cross sections at higher and lower impact energies; however, wide discrepancies exist between measured and calculated cross-section values. For the heavier target gases, a power-law extrapolation of the present results is in disagreement with previous measurements. This disagreement is attributed to inappropriateness of the power law at energies where electron capture from inner electron shells is possible. (auth)

8454 TRIAL WAVE FUNCTIONS IN THE CLOSE-COUPLING APPROXIMATION. Smith, Kenneth; Conneely, M. J.; Morgan, L. A. (Univ. of Nebraska, Lincoln). Phys. Rev., 177: 196-203 (Jan. 5, 1969).

The theoretical and numerical consequences of choosing different trial wave functions in the close-coupling approximation are considered. In particular, calculations are carried out on the scattering of electrons by atomic systems with configurations $1s^22s^22p^q$, q = 2,3,4, where properly antisymmetrized bound configurations $1s^22s^22p^{q+1}$ are mixed with the trial continuum wave function. An alternative treatment, which eliminates the need for such bound configurations, is presented. (auth)

8455 NONRELATIVISTIC PARTIAL-WAVE SCATTERING OF ELECTRONS BY IONIZED ATOMS. Peixoto, E. M. A. (Indiana Univ., Bloomington). Phys. Rev., 177: 204-11(Jan. 5, 1969).

A nonrelativistic partial-wave analysis of scattering of electrons by positive and negative ions has been made. Differential cross sections for $O^-(^2P)$, $Na^+(^1S)$, and $Ne^+(^2P)$ were calculated for incident electron energies between 1 and 40 keV. In the case of $Na^+(^1S)$ the low-energy (<1000 eV) behavior of the differential cross section was investigated and the influence of exchange effects is discussed. Born-approximation calculations were also carried out and compared with the partial-wave results. Throughout the work, analytical Hartree−Fock wave functions were used to describe the scatterer, and from these functions the static potential was calculated from Poisson's equation. (auth)

8456 BEHAVIOR OF THE IONIZATION CROSS SECTION IN COLLISIONS OF HIGH-ENERGY ELECTRONS WITH HYDROGENIC ATOMS. Omidvar, K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 177: 212-18(Jan. 5, 1969).

The ionization cross section per unit range of the energy ϵ of the ejected electrons for collision of an incident particle of high energy E with an atomic system is given by $dQ/d\epsilon = E^{-1}[A(\epsilon)\ln E + B(\epsilon)$, where A and B are functions of ϵ, and the total cross section is given by $Q = E^{-1}[A_\tau \ln E + B_\tau]$. The coefficients $A(\epsilon)$ and $B(\epsilon)$ for the particular case of the atomic hydrogen are derived analytically an an expansion with respect to $k = \sqrt{\epsilon}$. The expansion converges for all values of k. By integrating $A(\epsilon)$ and $B(\epsilon)$ with respects to ϵ, A_τ and B_τ are obtained and compared with the values obtained by Bethe using a different method. The coefficients of the first two leading terms of the expression of $dQ/d\epsilon$ with respect to ϵ or $1/\epsilon$ when ϵ is small or large are found. A relationship for the average energy of the ejected electrons is given. Different features of the high-energy impact ionization and a certain connection between the ionization and the discrete level excitation are discussed. (auth)

8457 VIBRATIONAL EXCITATION IN ION–MOLECULE COLLISIONS: H^+, H_2^+, He^+, N^+, Ne^+, AND ELECTRONS ON N_2. Moore, John H. Jr.; Doering, John P. (Johns Hopkins Univ., Baltimore). Phys. Rev., 177: 218-23(Jan. 5, 1969).

A study has been made of the relative band intensities of the $\Delta v = -1$ sequence of the N_2^+ first negative system excited by H^+, H_2^+, He^+, N^+, Ne^+, and electrons. Projectile ion laboratory velocities from 6×10^6 to 1.7×10^8 cm/sec (100 eV to 13.5 keV) were used. At ion velocities greater than 10^8 cm/sec, the relative band intensities were found to agree with those predicted by the Franck−Condon principle and found in excitation by 150-eV electrons. Below this velocity the relative population of higher ($v' > 0$) vibrational states increased monotonically. At the lowest velocity used, the populations of the $v' = 0$ and $v' = 1$ vibrational states of N_2^+ $B\,^2\Sigma_u^+$ were found to be equal within experimental error while the higher-state populations increased many orders of magnitude above those predicted by the Franck−Condon principle. The vibrational excitation was found to be solely dependent on the projectile ion's laboratory velocity and independent of its chemical identity. No vibrational excitation was observed in the N_2 second positive system excited under similar conditions. It is suggested that the excitation effects in the N_2^+ first negative system occur by a mechanism involving perturbation of the target molecule's vibrational wave functions by the projectile ion. Implications of these results for other collision studies as well as atmospheric phenomena are discussed. (auth)

8458 EJECTED ELECTRON DISTRIBUTIONS. Garcia, J. D. (Univ. of Arizona, Tucson). Phys. Rev., 177: 223-9(Jan. 5, 1969).

Differential cross sections for production of secondary electrons in the ionization of atoms by charged-particle impact are examined in the classical binary-encounter approximation. General scalable expressions are given for both electron and heavy-charged-particle impact, and are compared with experimental and quantum treatments where possible. It is found that this formulation provides simple physical explanations of most features of ejected-electron energy and velocity distributions. Proton-impact results are found to be in excellent agreement with experiment, and the electron-impact results converge to the Born results as expected. (auth)

8459 IONIZATION IN LOW-ENERGY ATOMIC COLLISIONS OF NEON WITH NEON AND KRYPTON WITH KRYPTON. Amme, Robert C.; Haugsjaa, Paul O. (Univ. of Denver). Phys. Rev., 177: 230-2(Jan. 5, 1969).

Neutral atomic beams of neon and krypton have been used to measure the total ionization cross section for symmetric collisions as a function of energy. The beams were produced by symmetric charge transfer of ions produced in an electron-impact ion source with low-energy electrons. Beam energies ranged from below the ionization thresholds to 2000 eV for neon and to 1000 eV for krypton. Neutral-beam intensities were determined by the measurement of slow- and scattered-ion currents generated in the charge-transfer cell. It is found that the Ne−Ne ionization cross section is a rather smoothly varying function of energy, while that for Kr−Kr collisions exhibits structure. The two cross sections become equal at approximately 130 eV incident energy, above which the Kr−Kr cross section remains below that for Ne−Ne. Results are compared with those by Flaks at higher energies and those by Bussmann and Rostagni at intermediate energies. (auth)

8460 ENERGY AND ANGULAR MOMENTUM DISTRIBUTION OF ELECTRONS EMITTED FROM K AND L SHELLS BY PROTON IMPACT. Choi, Byung-Ho (Univ. of North Carolina, Chapel Hill); Merzbacher, Eugen. Phys. Rev., 177: 233-9(Jan. 5, 1969).

Explicit expressions for the semiclassical transition probabilities of atomic K- and L-shell electrons into the continuum as a result of proton collisions are obtained as functions of proton-impact parameter and energy transfer. First-order time-dependent perturbation theory with undeflected proton trajectories is used. Calculated energy distributions for the ejected electrons are compared with the plane-wave Born-approximation cross sections. The contributions from various partial waves are shown in illustrations. The validity of the calculation is limited by the neglect of the Coulomb deflection of the protons. (auth)

8461 M ABSORPTION SPECTRA OF THORIUM AND URANIUM. Cauchois, Yvette; Bonnelle, Christiane; Manescu, Ioana (Laboratoire de Chimie Physique, Paris). Compt. Rend., Ser. A and B, 817-20(Oct. 14, 1968). (In French).

The comparative measurement of the M absorption spectra of

Th and U in the metal and the oxide (ThO_2 and UO_2) were reported. The energies of the discontinuities were compared with the energy levels calculated by ratio to L_{III} beginning with x emissions and with the bonding energies determined by electron spectroscopy. (tr-auth)

8462 ENERGY LOSS OF LOW-ENERGY PROTONS AND DEUTERONS IN EVAPORATED METALLIC FILMS. Morita, Kenji; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 25: 1525-32(Dec. 1968).

The energy losses, the energy stragglings, and the charge exchanges of protons and deuterons in the evaporated metallic films Be, Al, Cu, Ag, and Au were measured in the energy range of the incident particles from 7 to 40 keV. The experimental stopping cross sections of Be, Al, Cu, Ag, and Au for protons are approximately proportional to $V^{0.8}$ and are also approximately proportional to square roots of the atomic numbers of the stopping substances. The electronic stopping cross section of Cu for protons shows a good agreement, in the velocity scale, with that for deuterons measured with the same foil within the experimental error. The experimental energy straggling $\Omega^2/\Delta E$ is proportional to $E^{0.8}$ and to the 0.68-th power of the atomic number of the stopping substance. The experimental stopping cross sections and energy stragglings are compared with Lindhard's theoretical calculations. The measured population ratios of hydrogen atoms to protons in the emergent beam were found to agree approximately with the theoretical calculations by Bohr and Lindhard. (auth)

8463 DIAGRAMMATIC MNEMONIC FOR CALCULATION OF CASCADING LEVEL POPULATIONS. Curtis, L. J. (Univ. of Toledo). Amer. J. Phys., 36: 1123-5(Dec. 1968).

A diagrammatic procedure is described, by which the time dependence of the population of any level in a decay scheme of arbitrary complexity can be prescribed directly in terms of transition probabilities and initial populations, without specifically solving the determining differential equations. (auth)

8464 CONFIGURATIONAL INTERACTION OF TERMS IN THE ZeZ' SYSTEM. Ponomarev, L. I. (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 55: 1836-44(Nov. 1968). (In Russian).

The phenomenon of pseudointersection of terms in the ZeZ' system recently discovered is investigated. The WKB method is employed for deriving formulas for the magnitude of level splitting δE at the pseudointersection point, the distance R_0 between the charges Z and Z' at which they appear, the energy E_0 at this point and also the function that determines the total number of such pseudointersections in the ZeZ' system for given values of the charges Z and Z' and quantum numbers n and n' of the interacting terms. The formulas obtained are compared with numerical calculations. (auth)

8465 MEAN EXCITATION POTENTIAL OF LIGHT COMPOUNDS. Tschalaer, C.; Bichsel, Hans (Univ. of Southern California, Los Angeles). Contract AT(04-3)-136. Phys. Rev., 175: 476-8(Nov. 10, 1968).

The mean excitation potentials I of Al, Si, Al_2O_3, SiO_2, and $C_5H_8O_2$ were determined to an accuracy of ±0.5% by fitting theoretical range functions to experimental energy-loss data. The I values for the compounds were found to be 7 to 11% larger than the corresponding values calculated for mixtures using Bragg's rule. (auth)

8466 POLARIZATION OF THE SINGLET-TRANSITIONS OF He EXCITED BY PROTON IMPACT. Scharmann, A.; Schartner, K.-H. (Univ., Giessen, Ger.). Z. Phys., 219: 55-69(1969). (In German).

The polarization degree of the n $^1S-2\ ^1P(n = 3,5)$-, n $^1D-2\ ^1P(n = 3,4,5)$- and n $^1P-2\ ^1S(n = 3,4)$-transitions of helium excited by proton impact has been measured in the energy range of 100 keV to 1 MeV. The results, in connection with respective H_2^+- and e^--impact values are used in a comparison with the principal statements of the first Born and the Bethe–Born approximation. The results are in a qualitative agreement with the theoretical calculations. (auth)

8467 GLORY SCATTERING OF LITHIUM BY A SERIES OF MOLECULES. I. DIATOMICS. Helbing, Reinhard K. B.; Rothe, Erhard W. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 48: 3945-55(May 1, 1968).

The velocity dependence of the total cross section was measured for the scattering of lithium-7 by D_2, N_2, O_2, CO, NO, HF, HCl, DCl, HBr, HI, ICl, Cl_2, and Br_2. Glory undulations are observed for all systems except Cl_2 and Br_2 although in some cases these undulations are considerably smaller than might be expected for comparable atom–atom scattering. Potential parameters are derived for these systems. Chemical reaction, time-dependent anisotropic potentials, and inelastic processes are discussed as possible mechanisms for the observed quenching. (auth)

8468 CALCULATION OF THE INELASTIC BACKSCATTERING AND TRANSMISSION COEFFICIENTS OF MEDIUM-ENERGY ELECTRONS. Ostroukhov, A. A. (Kiev State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 1649-56(Jan. 1969). Translated from Fiz. Tverd. Tela, 10: 2105-14(July 1968).

In the continuous energy-loss approximation, a recursion relation is obtained for the probabilities w_n, making it possible to calculate the energy and spatial distribution of electrons inside a layer of matter of finite thickness and also the differential coefficients of the inelastic backscattering and transmission due to electrons which undergo n elastic scatterings in the layer. For the case of a quadratic stopping law, the coefficients of backscattering due to singly and doubly scattered electrons have been calculated. It is shown that with the existing expressions for the stopping law and the elastic scattering cross section, the contribution of such electrons to the total backscattering coefficient is small in the case of light substances and decreases rapidly with increasing Z. (auth)

8469 M ATOMIC RAYS OF URANIUM. Lachere, Georges (Laboratoire de Chimie Physique, Paris). Compt. Rend., Ser. A and B, 267: 821-3(Oct. 14, 1968). (In French).

The M emission spectrum of metallic uranium was studied. The group of atomic rays was measured and compared with previous measurements and with values calculated from energy levels. The experimental and calculated results are tabulated. (tr-auth)

8470 RESONANCE CHARGE TRANSFER OF SLOW CESIUM IONS. Palyukh, B. M.; Savchin, L. S. (Lvov State Univ.). Zh. Tekh. Fiz., 38: 1055-60(July 1968). (In Russian).

The effective resonance charge transfer cross section Q for cesium is determined using the retarding field method with ion energies in the range 1 to 150 eV. A new source of low-energy ions is used which consists of a glass bulb with internal molybdenum electrodes. The ions are formed by collisions of cesium atoms with the surface of a tungsten plate whose temperature determines the energy of the ions. The cross section Q is evaluated by the attenuation of the ion beam in a gas, which is described by $I = I_0 \exp(-p_0 Ql)$, where I is the ion current after passage through the collision chamber of length l cm, I_0 is the ion current into the collision chamber, and p_0 is the vapor pressure of cesium in mm Hg reduced to OC. The ion current as a function of collector retarding potential is presented graphically for several values of ion energy and cesium vapor pressure. The obtained values of Q are plotted as a function of ion energy together with the theoretical curve and some experimental results of other authors. The present results are considered to be more reliable; the error in determining the values of Q does not exceed 20%. (ATD)

8471 RESONANCE CHARGE TRANSFER OF SLOW POTASSIUM IONS. Palyukh, B. M.; Savchin, L. S. (Lvov State Univ.). Zh. Tekh. Fiz., 38: 1061-4(July 1968). (In Russian).

The effective resonance charge transfer cross section Q for potassium is determined using the retarding field method with ion energies in the range 1 to 250 eV. The ions are formed by surface ionization on an incandescent tungsten plate and are directed into a beam by electrodes which determine the ion energy. The ion beam passes through a charge transfer chamber of length l and reaches a collector where the ion current is measured. The cross section Q is determined by the ion beam attenuation formula $I = I_0 \exp(-p_0 Ql)$, where I_0 is the ion current into the charge transfer chamber, I is the ion current after passage through the chamber, and p_0 is the saturated vapor pressure of potassium reduced to OC. Plots of the ion current as a function of the accelerating potential are shown for several values of ion energy and vapor pressure. The obtained values of Q are presented graphically as a function of ion energy and compared with the theoretical curve and experimental results of other authors. Similar curves for cesium are shown for comparison. (ATD)

8472 POSITRONIUM IN IONIC COMPOUNDS. Colombino, P.; Fiscella, B. (Univ., Turin). Nuovo Cim., 58B: 413-20 (Dec. 11, 1968).

Positron annihilation has been studied in some ionic compounds such as hydroxides and sulfates by two-quantum angular measurements. It is concluded that a fraction of the positrons, those not forming positronium, annihilate almost exclusively in the neighborhood of the negative ion, oxygen, while the remaining fraction forms positronium atoms. This fraction has been derived for each sample and plotted against the percentage of volume that in matter is external to the ionic spheres: a quasi-linear dependence is seen and is deduced by starting from considerations on the "Ore gap". (auth)

8473 EFFECT OF SCATTERER THICKNESS ON MOTT-SCATTERING ASYMMETRY. II. EXPERIMENT. Braicovich, L.; De Michelis, B.; Fasana, A. (Politecnico, Milan. CNR, Milan). Nuovo Cim., 58B: 460-6(Dec. 11, 1968).

The effect of scatterer thickness on Mott-scattering asymmetry is experimentally investigated in the energy interval between 0.255 and 1.38 MeV and in the angular region between 108.5° and 156.5°; two gold scatterers 4.85 and 10.72 mg/cm^2 thick are used. On the basis of the experimental results the validity limits of the theoretical treatment of the problem given in a preceding paper are discussed. (auth)

8474 SENSITIVITY OF SPIN POLARIZATION TO SCATTERING POTENTIAL. Yates, A. C.; Fink, M. (Indiana Univ., Bloomington). Phys. Rev. Lett., 22: 1-3(Jan. 6, 1969).

The electron-spin polarization and differential cross section of electrons scattered on gaseous targets have been calculated using three different scattering potentials. The calculations were carried through for electrons with 340-eV incident energy scattered on Hg. The results show that the spin polarization changes very little when the potentials are varied. The differential cross section, however, changes considerably and is therefore of more basic significance than the spin polarization when atomic systems are investigated. (auth)

8475 MANY-BODY THEORY FOR TIME-DEPENDENT PERTURBATIONS IN ATOMIC SYSTEMS. Dutta, N. C.; Ishihara, T.; Matsubara, C.; Das, T. P. (Univ. of California, Riverside). Phys. Rev. Lett., 22: 8-12(Jan. 6, 1969).

A many-body approach for the calculation of time-dependent properties of atoms is developed and applied to the helium atom. The refractive indices and excitation energies so obtained are in excellent agreement with experiment. (auth)

8476 MEASUREMENTS OF L_2- AND L_3-SUBSHELL FLUORESCENCE YIELDS IN HEAVY ELEMENTS. Price, Richard E. (Univ. of California, Berkeley); Mark, Hans; Swift, C. D. Phys. Rev., 176: 3-10(Dec. 5, 1968).

Measurements have been made of L_2- and L_3-subshell x-ray fluorescence yields, ω_2 and ω_3, for elements Z = 71 through 83, 90, and 92. The method consisted of photoexciting K-shell vacancies in thin metal or oxide samples; observing with a Ge(Li) spectrometer the $K\alpha_1$ and $K\alpha_2$ x rays emitted as the K vacancies were filled by electrons from L_3 or L_2 subshells; and counting, with a detector of calculated efficiency, the L x rays (unresolved) that signify radiative filling of these vacancies. The directly measured quantities were ω_3 and $\nu_2 = \omega_2 + f_{23}\omega_3$. The quantity f_{23} was taken as 0.13 ± 0.13 to estimate ω_2. The estimated precision (2 standard deviations) varies between 8 and 15%. The ν_2 data agree with previous work. The ω_2 values lie above most previous results. The ω_3 values substantiate other recent experimental work, but exceed earlier estimates. The yields increase monotonically with increasing atomic number, within the limit of precision. Results with an alternative experimental arrangement indicate a small angular correlation in K–L_3–M, N x-ray cascades. (auth)

8477 FORMATION OF IONIZED EXCITED STATES THROUGH THE LOSS OF THE METASTABLE ELECTRON IN NOBLE-GAS ATOMS. Koozekanani, S. H. (Ohio State Univ., Columbus). Phys. Rev., 176: 160-3(Dec. 5, 1968).

It is shown that when the metastable electron of a noble-gas atom is removed by a fast collision it is quite possible for the atom to be ionized and excited at the same time. Excitation cross sections for the processes $np^5(n+1)s \xrightarrow{-e} np^4 - ml''$ or $np^5(n+1)s \xrightarrow{-e} np^4 - ml''$ have been calculated in terms of the cross sections for removing the electrons. (auth)

8478 EQUILIBRIUM CHARGE DISTRIBUTION IN HEAVY-ELEMENT ION BEAMS. Nikolaev, V. S.; Dmitriev, I. S. (Moscow State Univ.). Phys. Lett., 28A: 277-8(Dec. 2, 1968).

Unified approximate semi-empirical formulas for the mean charge, $\bar{l}$, and width, d, of the equilibrium charge distribution in fast ion beams after passage through solids have been obtained for all particles with atomic number Z ≳ 20. (auth)

8479 INVESTIGATION OF TIME CORRELATION OF PHOTONS EMITTED BY EXCITED ZENON ATOMS. Skachkov, Yu. F Zh. Eksp. Teor. Fiz., 55: 2047-52(Dec. 1968). (In Russian).

Time correlation of photons appears during excitation of xenon atoms by electron impact. With respect to magnitude, the correlation is equivalent to "simultaneous" (for times of the order of 5×10^{-7} sec) emission on the average of 2.2 ± 0.3 photons per excitation act of the xenon atoms. A calculation in which intensity of the excited cascade transitions is taken into account yields a correlation equivalent to "simultaneous" emission of not more than 1.27 photons per act. (auth)

8480 INVESTIGATION OF DISSOCIATIVE IONIZATION OF N_2 MOLECULES DUE TO EXCITATION OF VIBRATIONAL MOTION OF NUCLEI INDUCED BY COLLISIONS WITH FAST IONS AND ATOMS. Gusev, V. A.; Polyakova, G. N.; Fogel, Ya. M. (Ukrainian Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 55: 2128-35(Dec. 1968). (In Russian).

The formation of N^+ and N_2^+ ions produced by collisions of fast hydrogen, helium, neon, and argon ions and atoms (3 to 37 keV energy) with nitrogen molecules is studied by the mass-spectrometer technique. The relative populations of the first vibrational level of the $B^2\Sigma_u^+$ state of the N_2^+ ion are measured simultaneously for the same elementary processes by an optical spectroscopy technique. It is concluded on the basis of the experiments that the formation of N^+ ions is the result of excitation of N_2^+-ion vibrational levels lying above the dissociation limit of the electron states of the ion. (auth)

8481 π^--MESON TRANSFER IN A MIXTURE OF HYDROGEN WITH OTHER GASES. Petrukhin, V. I.; Prokoshkin, Yu. D.; Suvorov, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 55: 2173-80(Dec. 1968). (In Russian).

Transfer of π^- mesons from hydrogen to heavier elements Z in H_2 + Z gas mixture is investigated. The capture probability is proportional to the nuclear charge Z and depends only on the relative concentration of the Z atoms. The features of transfer observed experimentally can be explained within the framework of the phenomenological model. (auth)

Cosmic Radiation

Refer also to abstracts 7753, 8422, and 8425.

8482 (AECL-3162) COSMIC RAY NM-64 NEUTRON MONITOR DATA. CHACALTAYA, BOLIVIA-I: OCTOBER 1966–DECEMBER 1967. Ahluwalia, H. S.; Mejia, G. R.; Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1968. 69p. (In English and Spanish). Dep. CFSTI. CAN $1.50.

Uncorrected and barometer corrected results from the cosmic ray station at Chacaltaya, Bolivia, are given in tabular form from October 1966 to December 1967. Normalized graphs of the neutron monitor and of the barometric pressure are also given. (auth)

8483 COSMIC BLACKBODY RADIATION. Dautcourt, G.; Wallis, G. (Babelsberg Observatory, Berlin. Physical-Technical Inst., Berlin). Fortschr. Phys., 16: 545-93(1968).

Three chapters are given on cosmic blackbody radiation. These include discussions on (1) observations, (2) local (galactic and metagalactic) consequences, and (3) cosmological interpretations. (M.O.W.)

8484 SOLAR MODULATION OF GALACTIC COSMIC RAYS. Gleeson, L. J.; Axford, W. I. (Univ. of California, San Diego). Astrophys. J., 154: 1011-26(Dec. 1968).

Beginning with the equations of the convection–diffusion model including energy losses, it is shown that the streaming of galactic cosmic rays in the solar-wind cavity can be neglected above a few hundred MeV per nucleon. For the case in which the diffusion coefficient is separable into radially and rigidity dependent parts, an integral is derived which relates the intensity at points within the cavity to that at infinity through an energy-loss parameter. This parameter is a function of energy; it is defined in terms of observable quantities and is identified, tentatively, as the mean energy lost by the cosmic-ray particles in moving into the interplanetary region. The integral is formally equivalent to that obtained by using Liouville's theorem. Experimental data for the modulation of protons and helium ions in 1963–1965 and electrons and protons in 1965–1966 are shown to behave as predicted, down to kinetic energies of a few hundred MeV per nucleon. The diffusion coefficient was proportional to the magnitude of the charge of the cosmic-ray species during these periods, and the analytical results are formally equivalent to those obtained for a heliocentric force field proportional to the magnitude of the charge of the cosmic-ray species. Making use of the observed lower limits of validity, it is shown that the e-folding distance for the diffusion coefficient lies between 0.8 and 1.6 A.U., thus setting limits on the radial dependence of the scattering process. Estimates are given of the changes in energy loss in the periods 1963–1965 and 1965–1966 and of the energy loss at solar minimum. (auth)

8485 POLARIZATION OF RADIO PULSES FROM EXTENSIVE AIR SHOWERS. Hazen, W. E.; Hendel, A. Z.; Smith, Howard; Shah, N. J. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 22: 35-7(Jan. 6, 1969).

Log-periodic, EW- and NS-arm antennas were used to investigate whether radio pulses from extensive air showers are polar-

ized perpendicularly to the earth's magnetic field. Up to three such pairs of antennas were operated simultaneously, and 32 events with 84 radio pulses were observed. In the polarization part of the experiment, there were 23 pulses recorded in EW antennas versus 7 in NS, suggesting some geomagnetic production of radio pulses. (auth)

8486 A STUDY OF DIURNAL ANISOTROPY BASED ON DIRECTIONAL MEASUREMENTS OF COSMIC RAY MESONS. Kawasaki, Shinkichi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 22: 107-17(June 1968).

Characteristic features of anisotropies in cosmic rays were studied from data obtained during the period 1958 to 1962 by means of counter telescopes, directed towards the East, West, North, and South, with an inclination of 32° from the zenith. The amplitudes and maximum local times of the diurnal variations of barometer-corrected data were obtained for each direction, for every year. In order to eliminate uncertainties due to atmospheric temperature effects and other unknown factors which might be identically affected for each directional component, subtracted diurnal vectors such as East−South, East−West, West−North, and South − North were derived for further analysis. The direction of cosmic-ray anisotropy outside the geomagnetic field was calculated on the basis of these adjusted vectors. In the process of calculation, different sets of numerical values of parameters (the parameter m shows the exponent of the rigidity spectrum of the anisotropy, the parameter P_1 is the upper limit rigidity value and the parameter n determines the asymptotic latitude angle dependence of the observed diurnal variation) were assumed, and the anisotropy specified for each set. It is possible to determine the most suitable set of these parameters by considering whether or not an identical anisotropy could be found from the four subtracted diurnal vectors. It was shown that, on the average, the direction of anisotropy is 90° east of the sun−earth line and the rigidity spectrum responsible for the anisotropy is flat. There is evidence of secular variation in that the upper limiting rigidity value decreased. The cutoff was hardly recognizable in 1958, but decreased to less than 50 GV in 1962. (NSA of Japan)

8487 INTEGRAL FLUXES OF PRIMARY COSMIC RAYS AT PALESTINE, TEXAS, AND FORT CHURCHILL, CANADA, NEAR SOLAR MINIMUM. Lommen, Paul Warren. Rochester, N. Y., Univ. of Rochester, 1968. 177p.

Thesis.

Using a balloon-borne Cherenkov-scintillation counter telescope the integral fluxes of six groups of particles were determined: γ rays with energy $\gtrsim$50 MeV and five groups of relativistic nuclei including protons, alpha particles, L nuclei ($3 \leq Z \leq 5$), M nuclei ($6 \leq Z \leq 9$), and H nuclei ($Z \geq 10$). The detection instrument is an enlarged version of the University of Rochester's instrument aboard the OSO-3 satellite. An upper limit of 10×10^{-3} $(cm^2\text{-sec-ster})^{-1}$ is placed on the isotropic gamma ray flux at 0 g/cm^2. At Fort Churchill the primary proton flux above 400 MeV was found to be $.26 \pm .03$ $(cm^2\text{-sec-ster})^{-1}$. The alpha particle flux above 765 MeV/n was found to be $.013 \pm .002$ $(cm^2\text{-sec-ster})^{-1}$. Both fluxes are for a Mt. Washington neutron monitor rate of 2438 and are in fair agreement with the previous results. At Texas the proton and alpha particle fluxes above 4.5 GeV for a Mt. Washington rate of 2430 were found to be $610 \pm 50 \times 10^{-4}$ and $105 \pm 12 \times 10^{-4}$ $(cm^2\text{-sec-ster})^{-1}$ respectively. (Diss. Abstr.) (TSS)

Direct Energy Conversion

8488 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC ELECTRIC POWER GENERATION. Von Bonsdorff, Magnus Gabriel (to United Kingdom Atomic Energy Authority). British Patent 1,135,200. Dec. 4, 1968. Filed May 20, 1965.

A magnetohydrodynamic power converter system is described in which working fluid exhausting from the converter is passed as heating fluid through a fluid heater arranged to heat the working fluid for a turbine. The working fluid is already compressed by compressing machinery driven by the turbine. Cooling prior to compression may be accomplished by heat exchange with an external medium. In a closed circuit arrangement of the system it is possible, by compressing the working fluid between the converter and the gas turbine, to use a smaller, more efficient gas turbine. Additionally, heat exchange may be effected between the working fluid, prior to compression, and the working fluid leaving the gas turbine, prior to its entering the heat source. A major advantage of transferring heat in this way is that it permits a lower temperature in the turbine. Not only does the heat exchanger, by reason of the lower temperature, facilitate compressor and turbine design but also, by virtue of its position in the circuit, it permits any seeding material, such as alkali metal, used as an ionizing material in the magnetohydrodynamic converter, to be removed on a cold trap principle to protect the turbine and compressor against corrosion or erosion. (UK)

8489 ELECTROGASDYNAMIC SYSTEMS. Wallbank, Roger Wickham (to Gourdine Systems Inc.). British Patent 1,134,446. Nov. 20, 1968. Filed Mar. 2, 1966.

Apparatus is described in which the working fluid moves in a flow path bounded on at least one side by the surface of a dielectric guide which defines the direction of the line of flow of the fluid, the path having upstream and downstream portions, ionized particles being produced in the upstream portion. The apparatus includes a collector electrode placed downstream of an attractor electrode and a corona electrode, and means for simultaneously establishing a field between the collector and ionizing electrodes; the corona and attractor electrodes are placed on the same side of the flow path. Improvements are incorporated relating to structural configurations for the dielectric fluid guide, multichanneling, ion replenishment, electrical energy feedback, ac operation, optimum applied electric field, optimum aspect ratio, electrogasdynamic conversion accompanied by cooling to render the conversion isentropic, and fluid flow characterised by a high Reynolds number. Applications of the system are described. (UK)

8490 ANALYSIS OF FAILURES OF THERMIONIC CONVERTERS. Rouklove, Peter (Jet Propulsion Lab., Pasadena, Calif.). pp 168-73 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

The failures of these thermal devices are grouped according to the part of the converter which was affected. The causes of failure are evaluated and recommendations for improvement are included. (auth)

8491 AVIATION AND SPACE: PROGRESS AND PROSPECTS. [Proceedings of] Annual Aviation and Space Conference, Beverly Hills, California, June 16–19, 1968. New York, American Society of Mechanical Engineers, 1968. 815p. $25.00. (CONF-680639).

Included are 98 papers on developments and concepts in spacecraft, power systems, propulsion, aircraft, and ocean systems. Individual abstracts were prepared for 7 of the papers dealing with radiation effects, isotopic power supply systems, and reactors. (H.D.R.)

For abstracts of individual papers see: 7701, 7702, 7924, 7925, 8490, 8492, and 9220.

8492 THERMIONIC CONVERTER LIFE AND FAILURE INVESTIGATION. Athanis, T.; Brosens, P.; van Someren, L. (Thermo Electron Corp., Waltham, Mass.). pp 143-55 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

This paper summarizes the results of a two-year effort to evaluate the operating life of thermionic converters, and their probable mode of failure under steady-state and cyclic conditions. Twenty-five planar thermionic converters were constructed and tested. Nineteen converters were subjected to life test, with eight operating on a cyclic basis of 55 min on−35 min off, and eleven operating in steady-state. Two of the cycling converters exceeding 1000 cycles of operation, completing 2280 and 1480 cycles. Five of the steady-state converters exceeded 5000 hours of continuous operation, with three completing 15,200, 11,800, and 7500 hours; the other two, still operating, had accumulated 9800 and 8500 hours, respectively, near the end of this program. The average power density output of the life-tested converters was 15.7 W/cm^2. All converters operated at an emitter temperature of 2000°K and an output voltage of 0.7 volt; they all employed polycrystalline rhenium emitters with an effective area of 2 cm^2, and molybdenum collectors, with a nominal interelectrode spacing of 2 mils; the emitters were formed either by vapor-depositing rhenium onto tungsten, or by pressure-bonding rhenium to tantalum. A fact of particular interest is that all of the seventeen converters that failed lost the output by open-circuit due to cesium leakage; no short-circuit failures were observed. The failures that occurred can be avoided with modern converter fabrication technology; furthermore, within the duration of the test of each converter, no steady degradation of output was detected. (auth)

8493 MHD ROTATING MACHINE. Sekiguchi, S.; Katsurai, M. (Tokyo Univ.). Denki Gakkai Zasshi, 88-7: 1273-82(July 1968). (In Japanese).

The MHD rotating machine, a new type of MHD machine, is proposed. It has many applications, being capable, by introduction of a rotating member, of free mutual conversion between the three energy states—electrical, mechanical, and fluid. The fundamental characteristics of this MHD rotating machine are derived, indicating its features. The conceptual construction and its practical examples, the application in a power plant, the operational characteristics as a power generator, and some examples of the conceptual design are described. (auth)

8494 SOLUTION OF THE KINETIC EQUATION FOR A THERMIONIC CONVERTER IN THE DISCHARGE MODE. Sonin, E. B. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 38: 434-41(Mar. 1968). (In Russian).

The differential moment equations are solved for the electron distribution function in a real thermionic converter, with allowance for the appropriate boundary conditions. The system of equations for the distribution function of the atoms over the excitation levels is also solved. The solutions are obtained by numerical methods for the yield, the actual distribution of the particles, the temperature, the potential, the current, and other quantities in the converter. Both locally homogeneous and inhomogeneous plasma are considered, and account is taken of both elastic and inelastic electron–atom collisions (impact of the first and second kind, ionization). The electric field is taken into account in the quasineutrality approximation (by adding the diffusion equations for the ions) and the effects of deviation of the electron distribution function from Maxwellian are briefly discussed. (ATD)

8495 COMPARISON OF PROBE AND OPTICAL METHODS FOR MEASURING LOW-TEMPERATURE CESIUM PLASMA PARAMETERS. Dyuzhev, G. A.; Kaplan, V. B.; Moizhes, B. Ya.; Pikus, G. E.; Shakhnazarova, G. A.; Yur'ev, V. G. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 38: 963-7(June 1968). (In Russian).

A comparison is made between spectroscopic methods and probe techniques for measuring plasma parameters in cesium thermionic converters. The electrode spacing is 1.5 mm, and the cesium vapor pressure 0.4 to 2 mm Hg. The free electron temperature is determined from the intensity of the continuum recombination spectra at the 6P level. The charged-particle density is determined from Stark broadening. These results are then compared with Langmuir probe profiles. Near the cathode, the two methods give almost identical values for T_e. Near the anode, the probe results are 400°K lower than the spectral data. The potential distribution and the ion current are then calculated by using species continuity equation. (ATD)

8496 75-MW MHD POWER PLANT NEARS COMPLETION. Evans, R. K. Power, 113: No. 1, 66-7(Jan. 1969).

The complete 75-MW station consists of two cycles: a primary open cycle incorporates the 25-MW MHD generator, whose combustion products pass through an exhaust-heat boiler. This, in turn, powers a steam turbine-generator of 50-MW net output. Condensate from the latter then circulates as coolant around the MHD generator and combustion chamber. A brief description of the operation of the system is given. (M.O.W.)

8497 THERMIONIC ELECTRON EMITTER. Gabor, Dennis; Albert, Michael Joseph (to National Research Development Corp.). British Patent 1,137,124. Dec. 18, 1968. Filed Dec. 23, 1964.

In thermionic emitters, particularly electron emitters to operate at high emission densities, the use of compounds containing nonmetallic elements (e.g., oxides, borides, and carbides of metals) has tended to reduce the electrical conduction and the heat conduction to the emissive surface. A method is described of forming a satisfactory electron emitter of certain metals alone, without the inclusion of appreciable amounts of compounds of those metals with nonmetallic elements. The emitter is formed of three metallic materials, viz., a porous matrix of a refractory metal, metallic material (the active metal) in an elemental state only, which is capable of being atomically adsorbed on the surface of the refractory metal, and further metallic material (a mobilizer) which has at least partial solubility in the active metal and whose alloy with the active metal wets the refractory metal, at least in the molten state. The active metal is at least one of the following: lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium, and thorium. Suitable refractory metals for the matrix are tungsten, tantalum, molybdenum, and rhenium. Suitable mobilizer metals are: titanium, zirconium, vanadium, chromium, manganese, iron, cobalt, nickel, osmium, iridium, platinum, ruthenium, rhodium, and palladium. One rare earth metal, yttrium or thorium, can also act as a mobilizer for another, for instance lanthanum for thorium. (UK)

8498 INVESTIGATION OF MHD CONVERTER WITH LONGITUDINAL AND TRANSVERSE LOADS. Pinchuk, V. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 91-4(July-Sept. 1968). (In Russian).

Analytical relations for the main energy characteristics of an MHD generator with transverse and longitudinal loads were determined. Electric coils were inserted in the external magnetic system of the high-performance transverse loads and an external useful resistance in the high-performance longitudinal load. Magnitudes of load parameters were determined for providing conditions of maximum specific power generation. The relation was obtained which determines the load parameter ratios and assures a fixed value of specific electric power per unit of plasma volume or the electrical efficiency. (tr-auth)

8499 LIQUID METAL FLOW IN MHD DUCTS WITH SEGMENTED ELECTRODES. Tolmach, I. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 85-90(July-Sept. 1968). (In Russian).

Utilization of the Montardi scheme with segmented electrodes for the MHD apparatus with isotropic conducting working media is proposed. The effects of increasing working forces (an order or more) in such a scheme in pump and generator regimes in comparison with traditional liquid-metal dc machines is shown. (tr-auth)

8500 ELECTRON INSTABILITIES IN LOW-PRESSURE THERMIONIC PLASMA DIODES. Yuan, King. Rochester, N. Y., Univ. of Rochester, 1968. 242p.

Thesis.

In an attempt to understand the origin and nature of large-amplitude, spontaneous current oscillations that are observed in low-pressure thermionic plasma diodes, the stability properties of a planar collisionless plasma diode are examined. A general mathematical formulation of the linear stability theory of a bounded, one-dimensional, inhomogeneous, current-carrying, collisionless plasma based on Vlasov and Poisson equations is developed. The stability analyses of several self-consistent steady-state solutions with different emitting particle velocity distribution functions, e.g., a Delta function, a rectangular, or a staircase, have been considered. In each case the dispersion relation is derived and discussed. The results obtained are also compared to the corresponding infinite plasma case. The hydrodynamic stability theory of a plasma diode is also given in the Appendices. (Diss. Abstr.) (TSS)

8501 SELF-EXCITATION OF MHD GENERATORS WITH LIQUID-METAL WORKING FLUIDS. Kirillov, I. R. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 95-8(July-Sept. 1968). (In Russian).

The process of self-excitation of conductivity was examined in a liquid-metal dc MHD generator. It was shown, that, in order to obtain a stable steady state of self-excitation in the absence of electric nonlinearity the following is required: (1) commensurability of electromagnetic force developed by the MHD generator and increased pressure created by the apparatus, and (2) definite acceleration characteristics of the apparatus, in that pressure, being created by it, can both decrease and increase with velocity increase. (tr-auth)

8502 LAMINAR VELOCITY PROFILE IN A RECTANGULAR CHANNEL OF AN INDUCTIVE MULTIPHASE MHD CONVERTER. von Grumbkow, Peter (Technische Hochschule, Brunswick). Energy Convers., 8: 19-27(Aug. 1968). (In German).

The operational characteristic of polyphase magnetohydrodynamic induction converters is widely influenced by the velocity which is disproportionately spread over the channel. Especially high losses are encountered in the slowly moving boundary layers. In Weh and von Grumbkow (Advd. Energy Conversion, 5: 57(1965)) a boundary layer moving with half of the maximum velocity was assumed for a channel with infinite width between the side plates in order to estimate the importance of this influence. Besides the electromagnetic forces, the viscosity has to be considered for the exact calculation of the velocity profile. Because of the viscosity the velocity at the channel walls is zero. The two-dimensional laminar velocity distribution in the rectangular channel of an inductive MHD converter is calculated by applying certain simplifications (no current displacement and well conducting side plates). The ohmic losses occurring in the flow medium are also determined. Certain conclusions regarding the stability of the flow can be drawn from the calculation of the friction factor. (auth) (UK)

Fluid Physics

Refer also to abstracts 8605, and 8606.

8503 TEMPERATURE DISTRIBUTIONS IN MHD CHANNELS WITH HALL EFFECT. Eraslan, Arsev H. (Univ. of Tennessee

Space Inst., Tullahoma). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 186-8(Jan. 1969).

The limiting fully developed temperature solution for the MHD channel flow problem including the Hall effect, by employing the simple complex formulation for both the momentum and energy equations, is presented. The proposed formulation results in simplification in the mathematical solution and is suitable for the numerical evaluation of the temperature distributions by a modern digital computer with complex arithmetic capabilities. (M.H.R.)

8504 ENERGY DISSIPATION IN MHD DUCT FLOW. Snyder, W. T.; Eraslan, A. H. (Univ. of Tennessee Space Inst., Tullahoma). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 150-1(Jan. 1969).

The analysis of the fully developed heat transfer in an MHD channel requires an evaluation of the average dissipation, both viscous and Joule heating, over the duct cross section. A method of evaluating the average dissipation over a duct of arbitrary cross-sectional shape is described. (M.H.R.)

8505 HALL EFFECT IN THE FLOW OF FLUIDS IN THE PRESENCE OF THIN PROFILES. Dragos, Lazare (Faculte de Mathematique et de Mecanique, Bucharest). Compt. Rend., Ser. A and B, 267: 579-81(Oct. 14, 1968). (In French).

Equations expressing the Hall effect in the flow of conducting incompressible, nonviscous fluids in the presence of a thin profile are derived. (J.S.R.)

8506 HYDROMAGNETIC FLOW NEAR AN ACCELERATED PLATE IN THE PRESENCE OF A MAGNETIC FIELD. Rao, V. V. Ramana (Andhra Univ., Waltair, India). Appl. Sci. Res. (The Hague), 19: 389-91(Oct. 1968).

Soundalgekav [Appl. Sci. Res., Sect. B, 12: 151(1965)] investigated the flow of an electrically conducting viscous incompressible fluid due to the accelerated motion of an infinite flat plate in the presence of a uniform magnetic field, when the magnetic lines of force are fixed relative to the plate. Evidence is presented which indicates that the conclusions of Soundalgekav seem to be wrong. (M.H.R.)

8507 HEAT TRANSFER IN LAMINAR FLOW IN A UNIFORMLY POROUS CHANNEL WITH AN APPLIED TRANSVERSE MAGNETIC FIELD. Shrestha, G. M. (Univ., Dundee, Scotland). Appl. Sci. Res. (The Hague), 19: 352-69(Oct. 1968).

The steady laminar flow of an incompressible, viscous, and electrically conducting fluid between two parallel porous plates with equal permeability has been discussed by Terrill and Shrestha. Using their solution for the velocity field, the heat transfer problems of (i) uniform wall temperature and (ii) uniform heat flux at the wall are solved here. For small-suction Reynolds numbers it is found that the Nusselt number, with increasing Reynolds number, increases for case (i) and decreases for (ii). (auth)

8508 TRANSITION FROM LAMINAR-TO-TURBULENT FLOW IN CHANNELS WITH CONDUCTING WALLS. Gnatyuk, V. V.; Paramonova, T. A.; Shmelev, Yu. K. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 156-7(July-Sept. 1968). (In Russian).

Experimental data are given according to resistance for liquid gallium flow in a transverse magnetic field in round stainless steel pipe in the transition from laminar-to-turbulent flow. The experiments covered the range of Reynolds numbers $3000 \leq R \leq 68{,}000$ and Hartmann numbers $0 \leq H \leq 120$. It is observed that there are two types of transition — critical and subcritical — in the flow of a liquid metal in a transverse magnetic field in pipes with conducting walls, just as in pipes with nonconducting walls. With the increase of the value of the conductivity parameter, like Hartmann numbers, the probability of subcritical transitions grows. (tr-auth)

8509 ON THE INVESTIGATION OF STEADY-STATE THREE DIMENSIONAL MHD FLOWS IN CHANNELS WITH VARIABLE PROFILES AND WITH A SYMMETRY PLANE. Kozyrenko, V. E. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 77-84(July-Sept. 1968). (In Russian).

Three-dimensional MHD flows in variable-profile channels were investigated, using the concept of quasi-two-dimensional approximations. The main difficulties of investigating three-dimensional MHD flow, which possesses one plane of symmetry, are the analysis of the flow in the quasi-two-dimensional approximation and constructing a certain curvilinearity in the case of a nonorthogonal system of coordinates that most simplify the formulation of boundary conditions. The system of equations obtained is described. (tr-auth)

8510 ON SOME NEW EHD PHENOMENA SIMILAR TO THOSE IN MHD. Balchitis, A. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 64-72(July-Sept. 1968). (In Russian).

The differential equation of electric field induction $\partial E/\partial t = \nabla \times (v \times E) - \nabla \times \nu_e (\nabla \times E)$ is given, where E is the stress vector of the electric field, v is the flow velocity vector, ν_e is the coefficient of electrodynamic viscosity, and t is time. This equation shows that the behavior of a significant quantity of liquid of gaseous dielectric in an electric field is determined by its coefficient of electrodynamic viscosity, since for a stationary liquid the equation takes the form $\partial E/\partial t = \nu_e \nabla^2 E$, i.e., the form of the equation of diffusion. The relation between hydrodynamic energy and the electric field energy is shown. If a substance is in a liquid of weakly conducting medium in the electric field, then the field lines are frozen and move with it. Therefore the medium acquires quasi-electric properties and the small disturbances of steady-state movement in it are propagated in the form of EGD waves. It is hypothesized that the theory of turbulent generation of electric fields, in general characteristics, explains the generation of lightning discharges in the earth's atmosphere. General conditions in the medium in which specific EGD phenomena can be observed were obtained. (tr-auth)

8511 ON THE FAST MHD SHOCK WAVE STRUCTURE. Dementii, O. I.; Dementii, S. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 59-63(July-Sept. 1968). (In Russian).

Structure of plane MHD shock waves of arbitrary intensity was analyzed in an environment with zero viscosity and finite thermal and electric conductivity. The equations lead to a system of two ordinary differential equations of first order. When the velocity of flow behind the wave is greater or equal to the isothermal sound velocity, the equations do not contain peculiarities in their area of relevance, and all of the thermodynamic quantities are continuous. When the velocity of flow behind the wave is less than the isothermal sound velocity, the equation contains the peculiarity, which leads to the velocity decrease (also density and pressure decreases) inside the wave profile. In addition to that, the magnetic field stress, temperature, and other parameters remain continuous. The result conforms with the Whitham criterion. (tr-auth)

8512 PLANE MHD JETS WITH VARIABLE CONDUCTIVITY. Shilova, E. I.; Shcherbinin, E. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 54-8(July-Sept. 1968). (In Russian).

The flow of plane MHD jets with variable conductivity is analyzed, where the magnetic field is assumed transverse, and conductivity in the jet is changed according to the law $\sigma = \sigma_0 u$ or $\sigma = \sigma_0 (1 - u/u_m)$. Equations show that, in the first case, the effective mixing zone increases exponentially with distance from the source; and, by increase of the magnetic field, the corresponding maximum velocity on the axis of jet is decreased exponentially. In the second case, in spite of reducing the mixing zones, the development of the jet is stopped a finite distance from the source (the maximum velocity becomes equal to zero). (tr-auth)

8513 AXIALLY-SYMMETRIC MHD FLOW IN THE VORTEX CHAMBER AT HIGH HARTMANN NUMBER. Glazov, O. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 43-53(July-Sept. 1968). (In Russian).

Laminar axially symmetric MHD flow in a cylindrical chamber of finite height with transfer of working substance by the electrodes is considered. It is assumed that the Hartmann number is large and that the flow may be divided into two areas: a field of the center of flow and a field of boundary layers on the chamber face. It is shown that boundary layers on faces can, in an essential way, have an effect on the main flow in the center. This influence is due to leakage currents in the boundary layer, which, being closed to the center of flow, strengthen the electrodynamic interaction of flow with the external magnetic field, and by the radial streams of liquid in these boundary layers, which under specific conditions, can turn out to be comparable with the complete discharge of liquid through the chamber. (tr-auth)

8514 ON SOME PECULIARITIES OF THE MHD BOUNDARY LAYER ON A PLATE. Tsinober, A. B.; Shtern, A. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 34-42(July-Sept. 1968). (In Russian).

Appraisals of the type of boundary layer in Navier–Stokes equations for arbitrarily oriented magnetic fields were conducted. It was established that emerging in a sloping field is a lifting force comparable to the friction resistance, and also, that with $N \gg 1$, flow in boundary layers for magnetic fields, arbitrarily changed along the layer, will be similar to the flow in the Hartmann sublayer. The linearized equations showed that in homogeneous fields, the velocity distribution on greater removal

from the front edge does not depend on the input profile. Results of the numerical estimates illustrate the possibility of control of boundary layers in nonhomogeneous fields. (tr-auth)

8515 PRESSURE LOSSES IN LIQUID METAL FLOW IN CIRCULAR PIPES IN PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Vulis, L. A.; Paramonova, T. A.; Shmelev, Yu. K. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 23-33(July-Sept. 1968). (In Russian).

Experimental results are presented on the relation of the pressure coefficient from Reynolds and Hartmann numbers to the laminar flow of liquid gallium in round pipes in uniform transverse (for $R_m \ll 1$). The experiments were conducted in copper and steel pipes with a wide variation of conductivity parameters for Reynolds numbers up to 20,000 and Hartmann numbers up to 200. The data obtained characterize the relation of the pressure coefficient and the conductivity parameter from stabilized laminar flow. Results showed that in commercial pipes actual loss of pressure because of the contact resistance will be, in several cases, less than that calculated. In addition, the experimental data coincide with calculated values on introduction of the effective value of the conductivity parameter. (tr-auth)

8516 INFLUENCE OF MAGNETIC FIELDS ON THE TURBULENT CHARACTERISTICS OF LIQUID METAL FLOW. Ibragimov, M. Kh.; Loginov, N. I.; Subbotin, V. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 19-22(July-Sept. 1968). (In Russian).

Experiments are described for measurement of turbulent pulsation rates by electromagnetic methods in liquid metal flow in round pipes. Results show that the magnetic field decreases the intensity of rate pulsations and the turbulent shearing stresses. (tr-auth)

8517 DISTRIBUTION OF SHEARING STRESS AND TURBULENT EXCHANGE COEFFICIENT IN THE FLOW OF LIQUID METALS IN MAGNETIC FIELDS. Ibragimov, M. Kh.; Loginov, N. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 14-18(July-Sept. 1968). (In Russian).

Shear stresses and turbulent exchange coefficients are estimated for flow of liquid metal in round pipes with electroconductive wall in the presence of transverse magnetic fields. Estimates were made on the basis of experimental data from the measurement of velocity profiles. (tr-auth)

8518 THE STABILIZATION OF PLANE PARALLEL FLOW IN TRANSVERSE MAGNETIC FIELDS (EXPERIMENTAL RESULTS). Branover, G. G.; Gel'fgat, Yu. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 9-13(July-Sept. 1968). (In Russian).

Plane-parallel flows at the front and rear sections of pipes were studied. It was found that for increasing fields, both laminar and turbulent flow rates in the front section are reduced sharply. The breakdown of steady-state MGD velocity profiles at the end of the magnet poles does not occur at once. For 1- to 1.5-gauge pipe the velocity profiles practically keep the same form in or out of the magnetic fields. The results are compared with theory of Manohar and Maciulaitis. An empirical relation is proposed for estimating the flow rate in the front section. (tr-auth)

8519 CONCERNING THE DEVELOPMENT OF UNITARY SEMI-EMPIRICAL THEORY OF TURBULENT PIPE FLOW IN PRESENCE OF MAGNETIC FIELDS. Branover, G. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 3-8(July-Sept. 1968). (In Russian).

A semi-empirical theory of MHD pipe flow at small magnetic Reynolds numbers is developed. The theory is developed in two variations: on the basis of MHD Reynolds equations and on the basis of a system of equations of balance of the second moments of velocity pulsations. The presence of magnetic field is considered not only by means of the members of equations, which express average volumetric electromagnetic forces or Joule dissipation, but through pulsation terms considering the means of mixing and solved in relation to Stuart number. The theory was applied to plane and axially symmetric flows in longitudinal magnetic fields and to the different variations of plane flows in transverse fields, both on smooth and rough pipe walls. (tr-auth)

8520 ANALYSIS OF REGIONAL EFFECTS IN MHD CHANNELS WITH SEMI-INFINITE ELECTRODES AT FINITE MAGNETIC REYNOLDS NUMBERS. Kozyrenko, V. E.; Teplyakov, V. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 153-7(July-Sept. 1968). (In Russian).

In a previous work of Kozyrenko (Magnit. Gidrodinamika, 2: 50 (1967), the general method of estimating the electromagnetic field in an MHD channel with finite or semi-infinite electrodes was presented. The equation of the problem was constructed in the form of an asymptotic expansion, corrected for $Re_m < 1$. It is noted that the aforementioned method can, without essential changes, be considered as the method of successive approximations. In addition, the limitation $Re_m < 1$ is removed; however, the question concerning the convergence of the successive approximations process emerges. A later investigation by Kozyrenko shows the convergence of this process at any value of Re_m. Relying on the aforementioned observations, two examples of estimation of electromagnetic field distribution in MHD-channels with semi-infinite electrodes are presented here. (tr-auth)

8521 OPTIMIZATION OF TOPOGRAPHY OF MAGNETIC FIELD IN CONDUCTING MHD APPARATUS. Grinberg, G. K.; Zander, Yu. K.; Kate, M. N. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 127-32(July-Sept. 1968). (In Russian).

Current fields and ohmic losses in rectangular-cross-section channels of the MHD apparatus were examined upon intersection by the incompressible conducting liquid with flow stabilized by magnetic induction. It was established that ohmic losses, because of regional currents, are decreased if one disperses magnetic induction according to isolines, pressed to the channel walls and to the central part of the imposed magnetic field, or increases it in the direction of the nonconducting channel walls. Equations are obtained by use of potential theory representations and the method of separation of variables. (tr-auth)

8522 LAMINAR AXIALLY SYMMETRIC MHD FLOW IN CURVILINEAR CHANNELS. Sych, V. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 107-15(July-Sept. 1968). (In Russian).

Two cases are considered of steady flow of viscous incompressible conducting liquids in axially symmetric channels with a transverse magnetic field. The channels have rectangular cross sections with the ratio of sides arbitrary. In the first case, conducting liquid is introduced through external electrodes and is removed through internal electrodes. The integral characteristics of flow obtained are used in the determination of certain vortex parameters of the MHD generator. In the other case, without liquid consumption, the liquid is rotated by electric current flow through it from an external source. From equations of this problem, expressions were obtained for the average velocity and angular momentum of the liquid, determining the working characteristics of the MHD drive with liquid metal. (tr-auth)

8523 ACCURATE ESTIMATE OF TURBULENT BOUNDARY LAYER ON NONCONDUCTING WALLS OF MGD CHANNELS. Skurin, L. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 99-106 (July-Sept. 1968). (In Russian).

The influence of electric and magnetic fields on the turbulent boundary layer of variable-conductivity gases compressed near the nonconducting walls of an MGD channel is appraised. It is assumed that the magnetic Reynolds number is small and that the conductivity is a scalar quantity. Questions concerning the relative magnitude of quantities in the equations of motion and energy that appear as a result of averaging electromagnetic terms and conductivity are discussed. From the semi-empirical theory of turbulence from ordinary gas dynamics and with the method of integral ratios, the problem was resolved in ordinary differential equations. Numerical estimates were made for cases with constant temperature and velocity on the external border of the boundary layer. (tr-auth)

8524 USE OF THE MOVING FRAME METHOD FOR FINDING THE STATIONARY SOLUTIONS OF THE SYSTEM OF EQUATIONS OF MAGNETOFLUIDODYNAMICS. Ignat, M. An. Univ. Timisoara, Ser. Stiinte Mat.-Fiz., 4: 167-89(1966). (In Rumanian).

The moving-frame method was used to find the stationary solutions of the system of equations of magnetofluidodynamics for the case of an incompressible electrically conductive fluid steadily rotating with a velocity $\vec{v} = \vec{\varphi} \times \vec{n}$. Under the same circumstances, Carini's system of equations is then studied for a few particular cases. (Rom. Sci. Abstr.) (auth)

Geophysics

8525 HANDBOOK OF SOVIET SPACE-SCIENCE RESEARCH. Wukelic, George E. (ed.). New York, Gordon and Breach, Science Publishers, 1968. 521p.

The handbook is divided into five major parts. Part 1 is essentially a directory of all rocket, satellite, and space-probe payloads launched in the USSR between Oct. 1957 and Dec. 1966. Scientific equipment and results associated with these launchings are summarized in Parts 2 and 3. Soviet activities associated with meteorological, geodetic, and communications satellites are described in Part 4. Part 5 treats the related topics of space tracking, manned space-station concepts, and attitudes concerning the existence of extraterrestrial life. (M.O.W.)

8526 TEMPERATURES OF THE EARTH'S UPPER ATMOSPHERE. Walker, J. C. G. (Yale Univ., New Haven); Spencer, N. W. Science, 162: 1437-42(Dec. 27, 1968).

The upper atmosphere consists of a mixture of gases—electrons, ions, and neutral particles—each of which has a distinct temperature. Since energy is exchanged between the gases, the different temperatures are related, but the relationship is complex. Topics considered include the upper atmospheric composition, formation of the ionosphere, measurement of temperature, space experiments, rocket measurements, temperature of the ionospheric electrons, and radar measurements. (W.D.M.)

8527 BEARING DEVIATION IN HF TRANSIONOSPHERIC PROPAGATION. I. EXACT COMPUTATIONS FOR SOME IONOSPHERIC MODELS WITH NO MAGNETIC FIELD. Rao, N. Narayana (Univ. of Illinois, Urbana). Radio Sci., 3: 1113-18(Dec. 1968).

Expressions are derived for the exact computation of bearing deviation and other high frequency radio ray-path parameters in a model ionosphere with no magnetic field, but with electron density varying in three dimensions. The three-dimensional variation is simulated by assuming a spherically symmetric ionospheric model, but with its center of curvature displaced from the center of the Earth and by launching the ray out of the plane containing the transmitter and the two centers of curvature. Some numerical results for the ray-path parameters are presented for the quasi-parabolic and quasi-linear models. (auth)

8528 BEARING DEVIATION IN HF TRANSIONOSPHERIC PROPAGATION. II. APPLICATIONS OF EXACT COMPUTATIONS. Rao, N. Narayana (Univ. of Illinois, Urbana). Radio Sci., 3: 1119-23(Dec. 1968).

This paper deals with two applications of the exact computations of the ray-path parameters and, in particular, the bearing deviations for an eccentric-model ionosphere with no magnetic field, derived in a companion paper. These are (a) evaluation of the ITSA three-dimensional ray-tracing computer program and (b) investigation of direction-of-arrival observations of hf radio waves. In both cases, very good agreement has been found between the two sets of results. (auth)

8529 DETECTION OF ELECTRIC-FIELD TURBULENCE IN THE EARTH'S BOW SHOCK. Fredricks, R. W.; Kennel, C. F.; Scarf, F. L.; Crook, G. M.; Green, I. M. (TRW Systems Group, Redondo Beach, Calif.). Phys. Rev. Lett., 21: 1761-4(Dec. 23, 1968).

An observation was made of low-frequency fluctuating electric fields generated in the Earth's bow shock. It was found that the wave amplitude is not a smooth function of space through the shock, but rather that it is strongly correlated with magnetic-field structures within the shock. (auth)

8530 EVIDENCE FOR A GEOELECTRIC FIELD OVER THE POLAR CAP. Katz, Ludwig; Rothwell, Paul L. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev. Lett., 21: 1764-6(Dec. 23, 1968).

During the period of high solar and geomagnetic activity between May 22 and 25, 1967, energetic proton fluxes were detected coming up the magnetic field lines from the Earth at high magnetic latitudes ($\Lambda \geq 65$ to 70°). Because of the peaking of the flux along the magnetic field lines, the existence of a radial polar electric field is suggested. The average electric-field value required is 0.14 V/m. (auth)

8531 POSSIBLE CONTRIBUTIONS OF FAST NEUTRAL PARTICLES TO THE FORMATION OF THE F2 LAYER. Fahr, H. J.; Blum, P. W. (Univ., Bonn). Earth Planet Sci. Lett., 5: 168-70(Nov. 1968).

Due to a mean relative velocity of the order of 20 km/sec between interstellar hydrogen and the Sun, interstellar gas succeeds in penetrating into the inner regions of the solar system. Fast neutrals of about 1000 eV kinetic energy will there be produced by charge exchange processes with solar wind protons. The effect on the ionosphere of those neutrals that are intercepted by the Earth was studied. It is shown that above 300 km these neutrals constitute an additional ionization source besides the euv radiation of the Sun. Its contribution to the total ionization at 1000 km is almost 25%, it diminishes to 4% at the height of the F2-layer maximum. (auth)

8532 IONOSPHERIC ELECTRON DENSITY DURING SOLAR ECLIPSE OF JULY 20, 1963. Cornellier, J. R.; Pound, T. R. Urbana, Ill., Univ. of Illinois, 1967. 46p.

Data obtained during the solar eclipse of July 20, 1963, were studied at many ionospheric stations in the U. S. and Canada. Five stations were particularly selected for analysis, viz: Anchorage (Alaska), Winnipeg, Ft. Churchill (Manitoba); Millstone Hill (Mass.); Ft. Monmouth (N. J.). Data from these stations are discussed according to height intervals between E, F1, and F2 regions of the ionosphere. The true-height data of these layers for the eclipse period were investigated to note the similarities and dissimilarities in the observations at the different stations and the probable causes of the observed behavior in the ionosphere. The electron density continuity equation is reviewed. The parameter S_{cat} related to the thickness of the F2 peak is discussed. (Meteorol. Geoastrophys. Abstr.)

8533 SPECTRAL, SPATIAL, AND TEMPORAL VARIATIONS OBSERVED FOR OUTER-ZONE ELECTRONS FROM 10 TO 1000 keV WITH SATELLITE INJUN 3. Fritz, Theodore A. Iowa City, Iowa, Univ. of Iowa, 1967. 194p.

Thesis

Spectral, spatial, and temporal variations of outer-zone electrons with energies from 10 to 100 keV observed with Injun 3 are presented. Electrons with $E_e \geq 40$ keV were constantly observed precipitating into the atmosphere for all latitudes, $\Lambda \geq 45°$. At latitudes below the high-latitude boundary, the flux of ≥ 40-keV electrons in the loss cone was observed to always be $\sim 10^{-2}$ that of the locally mirroring flux. There was usually a spike of precipitating ≥ 40-keV electrons observed at the high-latitude boundary and the flux of ≥ 40-keV electrons was usually observed to approach isotropy over the upper hemisphere at the position of the satellite at this boundary. Large intensities of electrons with energies not much greater than 40 keV were observed precipitating into the atmosphere for $\Lambda \geq 65°$ during magnetically quiet periods and the position of the high latitude outer zone boundary (intensity cutoff) was observed to vary by $\Delta\Lambda \sim 7°$ while no magnetic activity was occurring. The latitude where the ratio of the trapped to the precipitated ≥ 40-keV particle fluxes breaks from 10^{-2} toward one is introduced as a more meaningful concept of the high latitude limit to durably trapped ≥ 40 keV electrons than the usual intensity cutoff. Strong observational support was found for the model of Taylor and Hones (1965) which adiabatically accelerates and then precipitates solar wind electrons in the auroral zone during magnetically active periods. The existence of a 2-stream instability mechanism reported by Stix (1964) and discussed by Evans (1967) which can act during the intense ≥ 10-keV precipitation events was also given observational support. Evidence is presented for the existence of another mechanism which acts in the region of the satellite (200 km to 1000 km) almost constantly, directionally accelerates electrons with $E_e \leq 40$ keV toward the atmosphere, and produces isotropic electron pitch angle distributions over the upper hemisphere at the position of the satellite predominantly at low altitudes right on top of the atmosphere for the region of the outer zone $\Lambda \geq 65°$. (Meteorol. Geoastrophys. Abstr.)

8534 HANDBUCH DER PHYSIK. BAND XLIX/2. GEOPHYSIK III. TEIL II. (Encyclopedia of Physics. Volume XLIX/2. Geophysics III. Part II). Fluegge, S. (ed.). Berlin, Springer-Verlag, 1967. 635p. DM 168.-; $42.00. (In English and German).

Two sections are presented on radio observations of the ionosphere and lunar tides in the ionosphere. An abstract was prepared for each article. (W.D.M.)

For abstracts of individual papers see: 8535 and 8536.

8535 RADIO OBSERVATIONS OF THE IONOSPHERE. Rawer, K.; Suchy, K. pp 1-546 of Handbuch der Physik. Band XLIX/2. Fluegge, S. (ed.). Berlin, Springer-Verlag, 1967.

Radio observations of the ionosphere are discussed in terms of the theory of wave propagation, sounding techniques, interpretation of results and reduction of data, sounding results, other investigations from the ground, and space research and the terrestrial ionosphere. (W.D.M.)

8536 LUNAR TIDES IN THE IONOSPHERE. Matsushita, Sadami. pp 547-602 of Handbuch der Physik. Band XLIX/2. Fluegge, S. (ed.). Berlin, Springer-Verlag, 1967.

Observations of lunar variations in the ionosphere are discussed in terms of lunar tide analysis of ionospheric data obtained with vertical-incidence ionosondes and observations of tidal wind in the ionosphere by radio methods. The theory of lunar variations in the ionosphere is covered under the topics of lunar tidal variations in the surface atmosphere, lunar tidal winds and electric fields in the upper atmosphere deduced from geomagnetic lunar variations, and cause of lunar variations in the ionosphere. (W.D.M.)

8537 AMPLIFICATION OF HYDROMAGNETIC WAVES IN THE MAGNETOSPHERE. Criswell, David Russell. Houston, Tex., Rice Univ., 1968. 227p.

Thesis.

A model is presented which describes the amplification of 0.2 to 5 Hz hydromagnetic waves in the magnetosphere. Many basic features of 0.2 to 5 Hz micropulsation activity (Pc-1) can be understood in terms of this amplification model. The basic ele-

ments of the model are: (1) the theory of hm-wave propagation; (2) the theory of cyclotron-resonance interaction; (3) a model of the bounded magnetosphere; (4) a plasmasphere-plasma trough model of the magnetospheric plasma distribution; and (5) a model of the $\mu = 10-100$ MeV/gauss protons based on experimental observations. Five conceptual innovations concerning the source of micropulsations result from the analysis. (1) The $\mu = 10$ to 100 MeV/gauss protons amplify only the 0.2 to 5 Hz primary hm-waves by means of the cyclotron-resonance mechanism. (2) Hm-wave amplification in the plasmasphere supports the complete range of 0.2 to 5 Hz micropulsation activity. The radial extent of the plasmasphere controls the low frequency limit, the local time activity, and variation with magnetic activity of these emissions. (3) The plasma trough is the source region of a mid-frequency range (0.3 to 1 Hz) of micropulsation activity. The plasma density and geomagnetic field asymmetry control the frequency range and local time characteristics of plasma trough emissions. (4) A given micropulsation event may be induced by a primary hm-wave packet which is spatially narrow or by a group of primary hm-waves present over a wide range of geomagnetic field lines. (5) The differential energy flux distribution of the 10 to 100 MeV/gauss protons must be characterized by a maximum value for a μ_0 such that 10 MeV/gauss $< \mu_0 <$ 100 MeV/gauss. Independent information on the radial extent of the plasmapause must be available before one can specify the magnetospheric source region of a given micropulsation. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 7895, 7911, 8186, and 8228.

8538 (CEA-R-3515) USE OF SUPERCONDUCTORS FOR STORAGE AND DISCHARGE OF ELECTRICAL ENERGY. Sole, Jean (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). May 1968. 201p. (In French). Dep.

After recalling the elementary properties which led to superconductors being used for generating very strong magnetic fields, as well as the methods used to attain the required very low temperatures in practice, the author presents in its elementary form the principle of storage and liberation of energy. A more detailed analysis of the successive charging, trapping, storage and discharge operations shows up the different aspects of the problem and is followed by a review of the very small amount of research published up to now and also by a presentation of the original work which has been carried out in this field. It is already possible to use superconducting materials as they are (i.e., although their characteristics have been adjusted with a view only to obtain very strong magnetic fields). Much more will be obtained from superconductors when they have been correctly adapted to this new very promising application to the storage and discharge of electrical energy. (auth)

8539 (CONF-681020-(Vol.1), pp 7-16) LOW-TEMPERATURE SPECIFIC HEAT OF SOME CERIUM AND LANTHANUM LAVES-PHASE COMPOUNDS. Joseph, R. R.; Gschneidner, K. A. Jr. (Ames Lab., Iowa).

The low-temperature specific heat of the Laves phase intermetallic compounds $LaPt_2$, $CePt_2$, $LaRu_2$, and $CeRu_2$ were measured between 1.4 and 8°K and in fields up to 9.0 kOe. $LaRu_2$ and $CeRu_2$ were determined to be type II superconductors with transition temperatures of 3.20 and 5.92°K, respectively. The data on $LaPt_2$ indicate that it behaves like a normal metal with a specific heat comparable to pure copper. The magnetic susceptibility as well as the specific heat of $CePt_2$ indicate that it orders magnetically at 1.7°K. The cerium atom in $CePt_2$ appears to be trivalent in the paramagnetic region. (auth)

8540 OCCURRENCE OF SUPERCONDUCTIVITY IN LANTHANUM SESQUICARBIDE. Giorgi, A. L.; Szklarz, E. G.; Krupka, M. C.; Krikorian, N. H. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 17: 121-3(Jan. 1969).

La_2C_3, which crystallized in the bcc D_{5c} (Pu_2C_3-type) structure, was found to be superconducting over the entire homogeneity range with the transition temperature varying from a low of 5.9°K to a high of 11.0°K. The superconducting transition was fairly sharp for samples containing compositions at the limits of the homogeneity range with the entire transition occurring over a temperature span of about 0.3°K. (M.C.G.)

8541 SUPERCONDUCTIVITY AND BAND STRUCTURE FROM A SINGLE PSEUDOPOTENTIAL: ZINC AND CADMIUM. Allen, Philip B. (Univ. of California, Berkeley); Cohen, Marvin L.; Falicov, L. M.; Kasowski, R. V. Phys. Rev. Lett., 21: 1794-6 (Dec. 30, 1968).

Three values of the electron-phonon mass enhancement λ for zinc and cadmium are compared: one obtained from the ratio of the electronic-specific-heat density of states and the band-structure value calculated from a pseudopotential approach, one calculated directly by means of the same pseudopotential, and one extracted by other authors from values of the superconducting transition temperature T_c and the Debye temperature Θ. For both metals the agreement between all three λ values is very good, indicating the correctness and uniqueness of the pseudopotential. Calculations performed with other proposed pseudopotentials give very different values of λ. (auth)

8542 THEORY OF NONLOCAL SUPERCONDUCTORS IN A MAGNETIC FIELD. Schattke, W. (Univ., Kiel). Z. Naturforsch., 23a: 1822-33(Nov. 1968). (In German).

Starting from the BCS theory, an upper bound for the free energy is obtained by a combination of a variational method and perturbation theory. The variational equations obtained are nonlocal. The parameters of the perturbation calculation are the vector potential and the spatial variations of the order parameter, which have to be small. Boundary conditions are set for the case of diffuse reflection and pair breaking at the surface. As an example, the superconducting plate is discussed. (auth)

8543 DYNAMICS OF CURRENT FLOW THROUGH THE PHASE-BOUNDARY BETWEEN A NORMAL AND A SUPERCONDUCTING REGION. Kuemmel, Reiner (Univ. of Illinois, Urbana). Z. Phys., 218: 472-94(1969).

The time-dependent Bogolyubov Equations, which are derived in a slightly generalized form are applied to the problem of quasiparticle reflection from the phase boundary between a normal and a superconducting region. The momentum balance of current flow through the boundary is discussed. The supercurrent induced by a quasi-particle with excitation energy less than the maximum value of the pair-potential is calculated. (auth)

8544 POSITIVE IONS IN LIQUID HELIUM II. THE CRITICAL VELOCITY FOR CREATION OF VORTEX RINGS. Bruschi, L.; Mazzoldi, P.; Santini, M. (Univ., Padua. Consiglio Nazionale delle Ricerche, Rome). Phys. Rev. Lett., 21: 1738-40 (Dec. 23, 1968).

The results of experiments are reported from which the value of the critical velocity for quantized-vortex-ring creation by positive ions in liquid helium II was obtained. The temperature range between 1.0 and 1.5°K was investigated. The critical velocity depends on temperature above 1.1°K. (auth)

8545 MODEL FOR THE CORE OF A QUANTIZED VORTEX LINE IN HELIUM II. Glaberson, William I.; Strayer, Donald M.; Donnelly, Russell J. (Univ. of Oregon, Eugene). Phys. Rev. Lett., 21: 1740-4(Dec. 23, 1968).

It is proposed that a quantized vortex line in helium II has a central core of normal fluid extending over a distance of a few angstroms. Surrounding this core is a "tail," a region of excess density of rotons whose momenta are predominantly aligned oppositely to the direction of circulation of the superfluid. This model is used to calculate the drag on a negative ion trapped on a vortex line, and appears to account for experimental results satisfactorily. (auth)

8546 METALLIC HYDROGEN: A HIGH-TEMPERATURE SUPERCONDUCTOR. Ashcroft, N. W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 21: 1748-9(Dec. 23, 1968).

Application of the BCS theory to the proposed metallic modification of hydrogen suggests that it will be a high-temperature superconductor. This prediction has interesting astrophysical consequences, as well as implications for the possible development of a superconductor for use at elevated temperatures. (auth)

8547 THERMOMAGNETIC EFFECTS IN DIRTY TYPE-II SUPERCONDUCTORS. Maki, Kazumi (Tohoku Univ., Sendai). Phys. Rev. Lett., 21: 1755-7(Dec. 23, 1968).

The heat current associated with the motion of vortex lines in a dirty type-II superconductor is reconsidered microscopically and thermodynamically and it is shown that the heat-current operator $\vec{J}_Q^p$ employed previously by Caroli and Maki has to be replaced by $\vec{J}^h$ in the presence of a constant magnetic field H: $\vec{J}^h = \vec{J}_Q^p + H\vec{J}^M$, where $\vec{J}^M$ may be called the magnetization current. The entropy associated with a single vortex line S_D at all temperatures (and in the high-field region), which vanishes like T at low temperatures is recalculated. (auth)

8548 USE OF A HELIUM REFRIGERATOR FOR MOESSBAUER STUDIES. Chow, Y. W.; Greenbaum, E. S.; Howes, R. H.; Hsu, F. H. H.; Swerdlow, P. H.; Wu, C. S. (Columbia Univ., New York). Nucl. Instrum. Methods, 66: 177-80(Dec. 1, 1968).

A closed-cycle helium refrigerator for Moessbauer experiments is described. The vibrations caused by the refrigerator

mechanism are decoupled and suppressed from affecting the relative source-absorber motion. The equipment operates successfully with both radioactive and Coulomb-excited sources. Source and absorber are thermally connected to the cooling station of the refrigerator. The temperature of the source and absorber can be controlled by the helium gas pressure and by an electric heater. The operating range is 20 to 300°K for radioactive sources and 25 to 300°K for Coulomb-excited sources. Operation is convenient and economical. (auth)

8549 TRAPPING LIFETIME OF NEGATIVE IONS IN ROTATING SUPERFLUID HELIUM UNDER PRESSURE. Pratt, W. P. Jr.; Zimmermann, W. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 177: 412-28(Jan. 5, 1969).

Measurements have been made of the lifetime for the escape of negative ions trapped in rotating helium II as a function of temperature and pressure. These measurements concern lifetimes in the range from 10 to 1000 sec, and have been made between the temperatures of 1.09 and 1.68°K from the vaporization pressure to the solidification pressure. At constant pressure the lifetime decreases rapidly with increasing temperature. The curves of constant lifetime in the pressure-versus-temperature plane have negative slopes dP/dT and positive second derivatives d^2P/dT^2. The results have been interpreted in terms of the bubble model of the negative ion and the vortex-line model of the rotating superfluid. The interpretation suggests that the ion radius equals approximately 19.5 Å at saturated vapor pressures and decreases to a value between 12 and 14 Å at the solidification pressure. However, a significant discrepancy between theory and experiment casts some doubt on the radius values obtained. (auth)

8550 HIGH-SPEED VORTICES IN HELIUM. Jones, B. K. (Univ. of California, Los Angeles). Phys. Rev., 177: 292-9 (Jan. 5, 1969).

It is demonstrated that the energy of a vortex in He II should be increased when it is very near a boundary. This assumption is used to derive expressions for the critical velocity and supercritical flow in the bulk liquid and the film. The creation and annihilation of vortices is also discussed. (auth)

8551 THEORY OF SUPERCONDUCTIVITY IN A PHONON MODEL. Kulik, I. O. (Physicotechnical Inst. of Low Temperatures, Kiev). pp 4-17 of Elektronnyye Svoystva Metallov i Splavov. Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

An attempt is made to develop a theory of superconductivity in a phonon model at ultimate temperatures. It is also attempted to prove that this theory leads to results agreeing with the corresponding results of the theory of superconductivity based on the Hamiltonian model of Bardeen. Formulas are derived with the aid of the thermodynamic perturbation theory. The model potential is shown to lead to the same results as the Bardeen interaction potential. All of the thermodynamic corollaries of the proposed model are the same as for the conventional Bardeen theory. (ATD)

8552 SUPERCONDUCTIVITY OF Sn–In ALLOYS. I. MAGNETIZATION AND ELECTRICAL RESISTANCE. Aomine, Takafumi; Shibuya, Yoshio (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap., 25: 1289-98(Nov. 1968).

The magnetic transition of Sn–In alloys at temperatures near the critical temperature range became broad with the increase of temperature for alloys with more than about 1.6 at. % In (nominal), which showed magnetic hysteresis with trapped flux. These alloys did not have well-defined critical temperatures and the superconducting transition occurred in certain critical temperature ranges. These behaviors are thought to be due to the inhomogeneous distribution of impurities. In the most dilute alloy, a Sn–0.38 at. % In (nominal) specimen, the superconducting nucleation field H_{c3} exceeded the thermodynamical critical field H_c and supercooling occurred at lower temperatures. However, its supercooling field for the bulk H_c was nearly equal to H_{c3} near the critical temperature. This result is in agreement with the calculations by Feder and by Park. The energy gap obtained from the magnetization with Toxen's formula approached the BCS value, $3.5\ kT_c$ as the impurity increased. (auth)

8553 MAGNETIC PROPERTIES OF SUPERCONDUCTING NIOBIUM–TANTALUM ALLOYS. Ogasawara, Takeshi; Kubota, Yoji; Yasukochi, Ko (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 25: 1307-23(Nov. 1968).

The superconducting transition temperature and isothermal magnetization have been measured for a series of Nb–Ta alloys ranging from Nb–13 at. % Ta to Nb–83 at. % Ta. These alloys are characterized as dirty type-II superconductors; the electron mean free path l lies in a range from $0.1\ \xi_0$ to $0.3\ \xi_0$, where ξ_0 is the intrinsic coherence length. The Ginzburg–Landau parameter κ takes the maximum value of 4.1 at the composition Nb–50 at. % Ta. In concentrated alloys with compositions 20 ~ 80 at. % Ta, the temperature dependence of the generalized Ginzburg–Landau parameter $\kappa_1(T)$ accords with the theory for the dirty limit. Especially, the reduced parameter at 0°K, $\kappa_1(0)/\kappa$, is in excellent agreement with the theoretical value 1.20. This agreement between experiment and theory is attributed to the fact that the temperature dependence of both the thermodynamic critical field $H_c(T)$ and the upper critical field $H_{c2}(T)$ follows the microscopic theory. (auth)

8554 TRANSPORT COEFFICIENTS NEAR THE λ-TRANSITION OF HELIUM. Swift, Jack (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Kadanoff, Leo P. Ann. Phys. (N. Y.), 50: 312-22(Nov. 1968).

Transport coefficients are computed near the λ transition of helium by considering processes in which one transport mode breaks up into several. The conclusions are that first sound damping diverges as $|\epsilon|^{-1}$, second sound damping as $|\epsilon|^{-\frac{1}{2}}$ and thermal conductivity as $|\epsilon|^{-\frac{1}{2}}$ with $\epsilon = (T-T_\lambda)/T_\lambda$ for low frequencies. These results were first obtained via the dynamical scaling idea by Ferrell and coworkers. Less singular results are found at higher frequencies. (auth)

8555 MOBILITY OF THE ELECTRON BUBBLE IN SUPERFLUID HELIUM. Baym, Gordon; Barrera, R. G.; Pethick, C. J. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 22: 20-3(Jan. 6, 1969).

The phonon-limited mobility of the negative ion in He II is calculated; the results are in excellent agreement with recent experiments of Schwarz and Stark. (auth)

8556 FREQUENCY-PULLING EFFECTS IN JOSEPHSON RADIATION. Scully, Marlan O.; Lee, Patrick A. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 22: 23-6 (Jan. 6, 1969).

Using techniques developed in the quantum theory of the laser, it is shown that the frequency of the radiation emitted from a superconducting tunnel junction may be pulled slightly from $2eV/\hbar$, and a physical discussion and numerical estimate of the effect is presented. (auth)

8557 MICROSCOPIC THEORY OF A BOSE FLUID BELOW THE BOSE–EINSTEIN CONDENSATION TEMPERATURE. Shea, Dion Warren Joseph. Boulder, Colo., Univ. of Colorado, 1968. 198p.

Thesis.

A microscopic equilibrium theory of a Bose fluid below the Bose–Einstein condensation temperature is presented. An important feature of this theory is the presence of both positive energy, $\epsilon_+(p)$, and negative energy, $\epsilon_-(p)$, quasi particles (measured with respect to the chemical potential), as well as the macroscopically occupied zero-momentum state. A phenomenological theory of a Bose fluid, formally similar to the Landau theory of a Fermi fluid, is briefly developed using a double quasiparticle model. It is shown that the perturbation theory treatment of a Bose fluid can be formulated in terms of such a double quasiparticle model. The Bose fluid is then treated using a modification of the quantum statistical theory introduced by Mohling and based on the work of Lee and Yang. A quasiparticle ensemble is used in which the quasiparticle concept is introduced in the very beginning in order to ensure that the derived expression for the entropy satisfies Nernst's theorem. It is found that the Λ-transformation of the theory introduced by Mohling is considerably simplified. The Λ transformation completes the program of the quantum statistical theory to describe the Bose fluid entirely in terms of a quasi-particle representation. Explicit expressions for $\Delta_+(k)$, $\Delta_-(k)$, and $\Delta(0)$ — transformation functions introduced by the Λ transformation — are derived, and the quasi-particle energies are expressed in terms of these functions. The functions $-\Delta_+(k)$, $-\Delta_-(k)$, and $-\Delta(0)$ are identified as the interaction energy for positive-energy quasi particles, the interaction energy for negative-energy quasi particles, and the chemical potential. The energy spectrum satisfies the condition $\epsilon_2(0) = 0$. Explicit expressions for the momentum distribution, the ground-state energy, and the entropy are also derived through second order in the pair-function, or the quasi-particle reaction matrix, used in the theory. The resulting expressions agree with the phenomenological theory which was developed using the double quasi-particle model. The theory is expected to apply to liquid helium II, but such application has not been studied. (Disser. Abstr.)

8558 ULTRASONIC ATTENUATION IN THE MIXED STATE OF SUPERCONDUCTING VANADIUM. Ozaki, H.; Kajimura, K.; Ishiguro, T.; Mikoshiba, N. (Electrotechnical Lab., Tokyo). Phys. Lett., 28A: 300-1(Dec. 2, 1968).

The attenuation of longitudinal ultrasonic waves was measured in the mixed state of V. Comparison of the results obtained in V with those in Nb confirms the general dynamical properties in pure type-II superconductors. (auth)

8559 TECHNOLOGY FOR PREPARATION OF SUPERCONDUCTING LEAD RESONATORS. Boehnke, R.-D.; Zimmer, H. (Philips Zentrallaboratorium GmbH, Hamburg). J. Less-Common Metals, 17: 235-41(Feb. 1969). (In German).

In connection with the research on superconducting resonating cavities it was necessary to make bright, superconducting lead layers. Since lead in air is readily contaminated with an oxide layer the lead layer had to be part of a vacuum system, which had to be vacuum-tight down to temperatures of 1.5°K, i.e., the temperature region of helium II. For low electrical losses in the cavities, superconducting soldered connections had to be used. (auth)

8560 MUTUAL FRICTION IN He II NEAR THE SUPERFLUID TRANSITION. Ahlers, Guenter (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev. Lett., 22: 54-6(Jan. 13, 1969).

Measurements of supercritical heat flow in He II are consistent with a mutual friction constant which diverges near T_λ. They also explain the apparent depression of T_λ observed by Erben and Pobell, and the "critical heat flux" near T_λ reported by Bhagat and Winer. (auth)

8561 BEHAVIOR OF A SUPERCONDUCTOR IN A VARYING FIELD. Gor'kov, L. P.; Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2230-42(Dec. 1968). (In Russian).

The dynamic equations previously found for the model of a gapless superconductor are employed for calculating some nonlinear high frequency effects. The high frequency region is primarily considered, the parameter Δ mainly being determined by the time average of the square of field strength. As a matter of fact the results obtained do not depend on the nature of the model. In each given case the boundary of the high frequency region should be prescribed. The behavior of Δ near the boundary in the presence of a large-amplitude high frequency field is calculated for a superconductor of the first kind. The case of simultaneous action of constant and varying fields is also examined. Of particular interest is the effect of a high frequency field on the hysteresis pattern calculated for a stationary Ginzburg field. Formulas are derived which describe the destruction of superconducting films of various thickness in a varying field. Destruction of surface superconductivity by a high frequency field is calculated for superconductors of the second kind. In particular, the dependence of the field strength H_{c3} on the varying field amplitude is found and equations for the dynamics of the surface layer are derived. (auth)

8562 NONSTATIONARY EQUATIONS FOR SUPERCONDUCTORS WITH SMALL CONCENTRATION OF PARAMAGNETIC IMPURITIES. Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2443-52(Dec. 1968). (In Russian).

The dynamic properties of the model of a superconductor with a small amount of paramagnetic impurities resemble in many respects those of ordinary superconducting alloys. On the other hand equations describing the time variation of parameter Δ can be obtained in a certain temperature range near T_c. These equations significantly differ from those obtained previously for the case of gapless superconductivity. The equations are used for solving some problems relating to the dynamic properties of parameter Δ. In particular, the low-frequency range of an external field for which Δ adiabatically follows the field, is much narrower than could have been expected. (auth)

8563 THEORY OF SUPERCONDUCTIVITY OF QUASI-ONE-DIMENSIONAL STRUCTURES. Dzyaloshinskii, I. E.; Kats, E. I. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2373-5(Dec. 1968). (In Russian).

The effect of the finite probability of jumps between filaments on the nature of the superconducting transition is examined. It is shown that in a broad transition temperature range $\beta\epsilon_0 \lesssim T_c \lesssim \beta^{1/2}\epsilon_0$ (β is the jump probability, ϵ_0 the Fermi energy) the superconducting state retains characteristic "one-dimensional" properties. (auth)

8564 PLASMON MECHANISM OF SUPERCONDUCTIVITY IN DEGENERATE SEMICONDUCTORS AND SEMIMETALS. I. Pashitskii, E. A. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz., 55: 2387-94(Dec. 1968). (In Russian).

It is shown that a specific mechanism of superconductivity due to interaction between electrons and the low-frequency weakly decaying branch of collective longitudinal oscillations of an electron-hole plasma (i.e., by the so-called plasma sound) may exist in degenerate semiconductors or semimetals with appreciably different effective conductivity electron and hole masses ($m_n \ll m_p$) and with relatively large free carrier mobilities. The critical temperature for transition of the semiconductor (semimetal) to the superconducting state in this case is determined by the Langmuir (plasma) frequency or by the Fermi energy of "heavy" holes and in principle can be considerably higher than in metals ($T_c \sim 10^2$ °K). (auth)

8565 JOSEPHSON EFFECT ON SMALL-SIZE TUNNEL CONTACTS. Ivanchenko, Yu. M.; Zilberman, L. A. (Donetsk Physical-Technical Inst., Kiev). Zh. Eksp. Teor. Fiz., 55: 2395-2402(Dec. 1968). (In Russian).

It is shown that fluctuations result in an anomalous behavior of the Josephson current on tunnel contacts with a small cross section. The effect of various types of fluctuations on the direct and alternating Josephson currents is considered. The results agree with available experimental data. (auth)

8566 QUASI-CLASSICAL METHOD IN SUPERCONDUCTIVITY THEORY. Larkin, A. I.; Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2262-72(Dec. 1968). (In Russian).

It is shown that in the general case replacement of quantum-mechanical mean values by mean values of the respective classical quantities along all trajectories with a prescribed energy is not correct. The dependence of the penetration depth on field strength is found without assuming weakness of the interaction between the electrons and the field. The case of highly impure films is also considered. (auth)

8567 EFFECT OF HYDROSTATIC PRESSURE ON THE CRITICAL PRESSURE IN SUPERCONDUCTING Nb-Zr ALLOYS. Brandt, N. B.; Papp, E. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 2160-5(Dec. 1968). (In Russian).

The effect of hydrostatic pressure up to 20 kbars on the critical current in Nb–Zr alloys is studied in magnetic fields up to 30 kOe and at liquid helium temperatures. The critical current measurements were performed by a potentiometric method and by the Kim noncontact method. The critical current is found to increase under pressure; in the $Nb_{50}Zr_{50}$ alloy the increase is ~15% at P = 17.5 kbars. The critical current increase cannot be ascribed to variation of the main critical parameters due to compression. (T_c practically does not change at pressures up to 20 kbars and H_{c2} apparently decreases.) (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 8702.

8568 (ORNL-TM-2337) THERMONUCLEAR DIVISION CHRESTOMATHY, 1968. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 64p. Dep. CFSTI.

Brief summaries of research work carried out at ORNL during 1968 are presented. (M.O.W.)

Confinement and Heating

8569 (AEC-tr-7004) THE MOTION OF TRANSIT PARTICLES IN A SYSTEM WITH A MINIMUM B. Skosyrev, Yu. V.; Yurchenko, E. I. (Akademiya Nauk SSR, Moscow. Institut Atomnoi Energii). Translated from report IAE-1488. 9p. Dep. CFSTI.

An abstract for the original paper appeared earlier in NSA 22: 46100. (M.O.W.)

8570 (AEC-tr-7008) MOTION OF PARTICLES IN HELICAL FIELDS HAVING EQUIPOTENTIALS COINCIDING WITH THE MAGNETIC SURFACES. Popryadukhin, A. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated from report NP-17586. 18p. Dep. CFSTI.

An abstract for the original paper appeared earlier in NSA 22: 44077. (M.O.W.)

8571 (LA-4017) OPTIMIZATION OF THE $\int d\ell/B$ STABLE REGION IN A LINEAR QUADRUPOLE. Baker, D. A.; Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

Analytical calculations are made of the $\int d\ell/B$ stable flux in a linear quadrupole. Curves are given for determining the conductor spacing that, for a given plasma temperature, maximizes the number of ion gyro-radii across the stable field region when the design is subject to constraints on the force, injection field, field energy, and current. (auth)

8572 (MATT-653) APPLICATION OF THE ENERGY PRINCIPLE TO ASTRON-TYPE AND OTHER AXISYMMETRIC DEVICES. Johnson, John L.; Kulsrud, Russell M.; Weimer, Katherine E. (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1968. Contract AT(30-1)-1238. 19p. Dep. CFSTI.

The stability of Astron-type devices is investigated on the basis of a model in which the electrons in the E-layer are assumed rigid. It is shown that stability is given by the usual energy principle provided that the current density is replaced by the plasma current density. The theory of general axisymmetric systems of Bernstein et al. is extended to include this model, and the stability criterion is found to be given by a slightly modified second-order eigenvalue equation along the closed lines. In the very low-pressure limit the stability criterion is that $V'' < 0$. An expression for the critical pressure for ballooning modes is found in the next order in an expansion in pressure. The differential equation is solved numerically for explicit Astron-type configurations. (auth)

8573 (ORNL-TM-2360) NEUTRONICS CALCULATIONS AND COST ESTIMATES FOR FUSION REACTOR BLANKET ASSEMBLIES. Steiner, Don (Oak Ridge National Lab., Tenn.). Nov. 22, 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

The tritium breeding potential and the material costs of some thermonuclear blanket assemblies were investigated. These assemblies differ from previously proposed assemblies in the following aspects: (1) Niobium, rather than molybdenum, is employed as the structural material. (2) Lithium, or a combination of lithium and flibe (lithium-beryllium fluoride), rather than flibe alone, is employed as coolant. (3) No metallic beryllium is employed; graphite is the only neutron moderator present. Neutron fluxes and reaction rates were calculated with the ANISN, a one-dimensional, transport theory code employing an S_8 approximation for the angular flux and a P_3 approximation for the elastic-scatter-source term. In all cases the blanket geometry was idealized as a slab, and one hundred energy groups were employed. Blanket assemblies containing only lithium as coolant, yield tritium breeding ratios in the range 1.32 to 1.57. Blanket assemblies containing both lithium and flibe yield attractive tritium breeding ratios (i.e., ~1.2 or greater) only when the volume ratio of lithium to flibe is greater than 1:1. It is concluded that the blanket designs considered in this study offer a more attractive combination of tritium breeding ratio and material costs than do the earlier designs. (auth)

8574 VACUUM SYSTEM OF A TOROIDAL PLASMA MACHINE. Goldberg, R.; Liley, B. S. (Australian National Univ., Canberra). Vacuum, 18: 631-6(Dec. 1968).

The vacuum system associated with a slow toroidal $\theta-Z$ plasma pinch experiment is described. The basic element is an inconel vacuum vessel of approximately 100 litres volume. This vessel consists of four quadrants with insulating alumina spacers between quadrants. The vacuum seals are grease-free Viton A "O" rings, and the vessel is held together by atmospheric pressure alone. The high vacuum pump is a TVP 500, 150 litre/sec turbo-molecular unit, no cold traps being used. Base pressures of the order of 5×10^{-8} torr were consistently obtained. During a discharge spectroscopic observations imply the absence of arcing and the absence of oil vapours from the untrapped pump system. (auth) (UK)

8575 LN_2 RECOVERY SYSTEM FOR ALICE. Denhoy, B. S. (Univ. of California, Livermore). Cryog. Eng. News, 3: No. 12, 24-5(Dec. 1968).

The system described is capable of handling up to 30 gpm of liquid N_2 and is fully automated. (M.O.W.)

8576 EXPERIMENTAL STUDY ON THE PENETRATION OF HIGH-SPEED PLASMA INTO A CUSPED FIELD. Irisawa, J.; Suzuki, U. (Tokyo Inst. of Tech.). Denki Gakkai Zasshi, 88-5: 119-26(May 1968). (In Japanese).

When injecting a plasma into a symmetric cusped field with $\beta = 1$, the $\beta = 1$ injection is not necessarily advantageous because of the large plasma leak at the opposite point cusp. Therefore, injection experiments were made on a plasma of constant energy, keeping the discharge voltage the same, in the range of $\beta = 1$ to lower values. It was found that there exists a field strength for point cusp where the product of plasma density and temperature is largest; it is in the region of $\beta < 1$. Further, from consideration of the ratio of β in the first and in the second point cusp, the field strength of point cusp with a maximum plasma containment was found to agree with the point-cusp intensity where the injection is best made. Therefore, it is concluded that when using a symmetric cusp, the $\beta < 1$, not $\beta = 1$, injection is at an advantage. (NSA of Japan)

8577 AN ASYMMETRIC MINIMUM $\overline{B}$ CONFIGURATION WITH RESONANT WINDINGS OF OUTER CONDUCTORS. Suzuki, Yasuo (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1521(Nov. 1968).

It is shown that the toroidal configuration of low aspect ratio perturbed with helical and multipole fields can have new noticeable advantages in constructing the magnetic wells for the plasma confinement; those are the deep magnetic well, the large rotational angle and small mirror ratio along magnetic lines of force. (M.O.W.)

8578 A NEW SYSTEM OF TOROIDAL CONFINEMENT OF PLASMAS. Ikuta, Kazunari (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1485-95(Nov. 1968).

A new toroidal system having the average minimum B-field without buried conductors is discussed. The existence of the closed nested surfaces is shown by the averaging method. A systematic analysis for the relations between rotational transform angle, well depth and mirror ratio along field lines is made by numerical computation. The configuration with the modest well depth and the appreciable rotational transform angle is found, although the requirement for deep well depth contradicts with that for large rotational transform. (auth)

8579 THE GUIDING CENTRE OF A CHARGED PARTICLE IN A QUADRUPOLE MAGNETIC FIELD. Strijland, W.; Schuurman, W. (FOM-Instituut voor Plasma-Fysica Rijnhuizen, Jutphaas, Netherlands). J. Phys. Soc. Jap., 25: 1464-6(Nov. 1968).

The allowed region for the guiding center of a charged particle gyrating in a magnetic quadrupole field is investigated. The region consists mainly of a thin shell, near the line of force, around which the particle rotates. For very low values of the generalized angular momentum, the allowed region exhibits a bulge near the origin. (auth)

8580 A NEGATIVE V'' SYSTEM AND ITS EQUILIBRIUM. Amano, Tsuneo (Kyoto Univ.). J. Phys. Soc. Jap., 25: 1455-63 (Nov. 1968).

A negative V'' configuration is obtained by applying $l = 2$ and $l = 3$ helical multipolar fields on a toroidal magnetic field. An analytical and numerical analysis indicates that the negative V'' condition can be achieved in a wide region in this way. The plasma pressure effect on the configuration is also considered. (auth)

8581 DIFFUSION IN AN UNSTABLE STRONGLY INHOMOGENEOUS PLASMA. Buchel'nikova, N. S.; Salimov, R. A. Zh. Tekh. Fiz., 38: 986-90(June 1968). (In Russian).

Diffusion across a magnetic field and the oscillation correlation function in an unstable, strongly inhomogeneous plasma are measured. The plasma is formed by the surface ionization of potassium on tungsten at 2000°K. Plasma densities were 10^9 to 10^{10} cm^{-3} and the magnetic field strength was 400 to 1200 oersteds. The correlation function was measured by using an automatic correlograph which records the sign of the correlation function. Measurements indicate that the oscillation phase correlation is composed of five periods and that the diffusion across magnetic lines has a convective character, with a coefficient inversely proportional to the magnetic field. In absolute value, the diffusion coefficient is found to be close to the Bohm diffusion coefficient. (ATD)

8582 INVESTIGATION OF SOME CHARACTERISTICS OF PLASMA TRAPPED IN A TRANSVERSE MAGNETIC FIELD. II. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 1050-4(July 1968). (In Russian).

The trapping characteristics of plasmas injected across magnetic lines of force are discussed in some detail. In particular, the drift characteristics of the trapped plasma along the magnetic lines are investigated. Injection is accomplished by a conical source using pulses of hydrogen plasma. An $E \times B$ drift is shown to exist on charged particles moving along the lines of force, which is directed along the injection path. The plasma drifting along the field lines is collimated by a 7-mm slit–diaphragm 10 cm from the point of injection. The plasma configuration going through the slit was analyzed using a single channel screened electric probe. Plots are obtained of dN/dx versus x, (x is distance along the injection path) as well as the energy distribution function of trapped ions. Measurements show that the polarization field of a fast-diffusing plasma is only slightly lower than the field of the slow-moving plasma. The highest drift along the injection path is found to occur in the leading part of the fast plasma bunches injected across the field lines. (ATD)

8583 ATTENUATION OF MICROWAVE FIELD IN A PLASMA IN MAGNETIC FIELDS MUCH LARGER THAN THE CYCLOTRON FIELD. Budnikov, V. N.; Golant, V. E.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 576-9(Mar. 1968). (In Russian).

Inasmuch as earlier investigations of the use of microwave fields for the production and collision-free heating of plasma in magnetic traps were limited to weak magnetic fields, the authors experimented on the absorption of microwave power in a field exceeding the cyclotron field (3200 Oe). Special calibration measurements with the aid of a cavity resonator were made to determine

the dependence of the electron density in the plasma on the supply of microwave power (up to 150 kW). The absorption was measured at a frequency equal to one-third the cyclotron frequency. The tests revealed a strong attenuation of the transmitted signal at a certain critical plasma concentration, amounting to about one order of magnitude when the concentration varies within 40% about the critical value. This agrees with theoretical predictions made for a model in which plane waves propagate through a homogeneous cold collision-free plasma. It is concluded that effective absorption of microwave energy by a plasma is possible in a magnetic field much stronger than the cyclotron field, provided the collisions have a small influence. (ATD)

8584 VACUUM SYSTEM OF OGRA-II. Butuzov, S. S.; Zubarev, V. F.; Konyaev, V. P.; Maslennikov, E. A.; Nekrasov, A. N.; Pustovoit, Yu. M.; Svishchev, V. S.; Chukhin, I. A. Zh. Tekh. Fiz., 38: 285-95(Feb. 1968). (In Russian).

The vacuum system of the thermonuclear device Ogra-II is described. The apparatus consists of an ion injector, a neutralization chamber, a differential pumping system, and the working chamber in which the plasma is accumulated. Detailed data are presented on the apparatus, the pressure-measuring system, the residual-gas analysis system, the liquid nitrogen supply system, and the heating system of the setup. The preparation of the equipment for operation and the vacuum conditions are described. Results of tests on the differential pumping system, which ensures a pressure of 10^{-5} torr at the neutralization chamber and up to 10^{-9} torr at the working chamber of a length of three meters, are described. Methods of measuring the pressure in the chamber with the plasma present by a pulse method are discussed. (ATD)

8585 NEW MODEL FOR PLASMA CONFINEMENT TIMES IN STELLARATORS. Gorman, J. G.; Brown, I. G.; Lisitano, G.; Orens, J. (Princeton Univ., N. J.). Phys. Rev. Lett., 22: 16-20 (Jan. 6, 1969).

Subject to suitable restrictions, much of the data on confinement in stellarators are shown to fit a semi-empirical formula, viz., $\tau \propto BT_e r/n_e$. (auth)

8586 J-MIRROR, MAGNETIC BOTTLE USING THE LONGITUDINAL INVARIANT OF MOTION. Ohkawa, T. (Gulf General Atomic, Inc., San Diego, Calif.). Kakuyugo-Kenkyu, 22: No. 1, 15-21(Dec. 1968).

A magnetic bottle may be obtained by having a maximum of longitudinal invariant (J) in both the radial and the axial direction. The "loss disc" in this case is the region in the velocity space corresponding to small parallel velocities or small values of the invariant. Since the excursion of the orbit with a small J is confined to a small volume, the collisions only in this volume will lead to the loss of the particle. Consequently, the confinement time limited by collisions is much larger than that of the μ-mirror configuration. On the other hand, the constancy of J may be more readily destroyed by nonadiabaticity or low frequency electric fields. (NSA of Japan)

8587 A NEGATIVE V" WAVY TOROIDAL FIELD WITH HELICAL MULTIPOLE. 2. Miyamoto, Kenro (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 22: No. 1, 22-9(Dec. 1968). (In Japanese).

In a previous paper, the magnetic surface, V" and the rotational transform angle of a wavy toroidal field with helical multipole were studied by analytical approximations using an average method. In this paper these quantities are obtained by numerical computations and the results are compared with the analytical ones with good agreement. The case of l = 1 in this configuration is favorable to obtain larger rotational transform angle and it corresponds with a field of simple torus with off-axis helical dipole field. The features of this configuration are examined. (NSA of Japan)

8588 EXPERIMENTAL INVESTIGATION OF CUSP CONTAINMENT IN CHALICE. Harvey, Robin James. Hoboken, N. J., Stevens Inst. of Tech., 1968. 92p.

Thesis.

In the Chalice experiment D_2 gas at 120 m torr is preheated with a Z pinch, compressed with two opposed e pinches and injected into a cusp where measured electron densities of the order of 5×10^{17} cm^{-3} are maintained for 30 μ sec ($n\tau > 10^{13}$). The nature of the "dynamic mirrors" at the interfaces of the e-pinch fields with the pulsed cusp field is described. The loss rate from the cusp is shown to be consistent with a hole size of around an ion cyclotron radius. The size varies with the magnetic field, changing considerably when the field falls below the critical field needed to keep the plasma from "spilling-over." The decay time (1/e) of the plasma, when field effects are factored out, is shown to change from 60 to 23 μ sec at spillover. (Diss. Abstr.)

Diagnostics

Refer also to abstract 8630.

8589 ENERGY ANALYSIS OF CHARGED PARTICLES FROM A RADIO-FREQUENCY ION SOURCE. Torizuka, Kazuo (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., 20: No. 1, 5-14(Sept. 1968). (In Japanese).

When plasma is investigated, particle density and temperature are the most fundamental conditions. As for temperature, it is the problem to obtain the distribution of kinetic energy of constituent particles. The author devised the method of directly obtaining the kinetic energy distribution in the form of differential spectrum by carrying out the source modulation and using the narrow-band amplifier, and achieved success in the test measurement of energy distribution of ions from the rf ion source. This method is applicable to the other ion sources and to the energy analysis of charged particles in plasma, generally. The theory for measurement of ion energy distribution in ion beams obtained from the rf ion source is explained, and the construction of the rf ion source used for the experiment, the current characteristic of beam from the rf ion source, the integrated spectrum of kinetic energy of ions obtained, and the differential spectrum of kinetic energy of ion due to the source modulation were shown. The experiment confirmed that the energy analysis of beams can be performed simply and accurately with this method. (NSA of Japan)

8590 DISTORTION OF CHARACTERISTICS OF THE PLASMA PROBE. II. Sato, Yoshimasa (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., 20: No. 1, 15-19(Sept. 1968). (In Japanese).

When various amounts of plasma are measured with Langmuir probe, the voltage-current characteristic of the probe is distorted due to the rise of space potential of plasma, generated by the current flowing into the probe due to diffusion from the whole region of plasma, accordingly some correction is necessary. The amount of correction of the distortion is obtained by the measurement of change in the space potential generated by the probe current. For the determination of the space potential of plasma, three methods, utilizing the potentials at the intersection of extensions of two straight lines, the end point of straight part of the steeper line, or the inflection point, on the semi-logarithmic plotting of the voltage-current characteristic of the probe, are applicable. If the probe current changes, while the electron temperature, the ion temperature and the mass ratio of ion and electron remain unchanged, the amount of change in the space potential is the amount of change in the wall potential as it is, and it is enough to measure the amount of change in the wall potential, which is measurable more easily and accurately. The spherical discharge tube used for the measurement, the voltage-current characteristic of the probe in it, the energy distribution of electrons, and the distribution of the wall potential were described. In the case that the probe is small enough and the probe current is small enough compared with the discharged current, the required conditions are satisfied except in the vicinity of the probe. The amount of distortion was about 1.5V of space potential rise per 1 mA of probe current. (NSA of Japan)

8591 PROBLEM OF PLASMOID STRUCTURE IN A COAXIAL INJECTOR. Vasil'ev, V. I.; Komel'kov, V. S.; Tserevitinov, S. S. Zh. Tekh. Fiz., 38: 991-6(June 1968). (In Russian).

The structure of the frontal zone of a plasmoid ejected from a coaxial plasma generator is analyzed experimentally. The velocity front of the plasmoid is 2×10^7 cm/sec with a density of 5×10^{14} cm^{-3}. The measuring instruments consist of four diamagnetic probes to measure the plasma temperature, a thermal probe to register the incident energy (0.1 to 0.2 μsec resolution platinum wire), a monochromator to record the neutral deuterium and impurity atoms, and a Thomson mass spectrometer, located at the end of the coaxial gun. Analysis of the oscillogram data indicates that the frontal zone of the plasmoid consists of highly ionized deuterium (6 to 10 eV) which moves with a speed higher than the neutral or impurity tail behind it. Carbon and oxygen contribute 50% of the impurity ions in the plasmoid. The rest are nitrogen, sodium, calcium, and silicon ions. Impurities could be minimized by reducing contact with the plasma gun walls and by eliminating oil in the vacuum system. (ATD)

8592 SPECTROSCOPIC MEASUREMENTS OF WEAKLY IONIZED ARGON PLASMA JET. I. ELECTRONIC EXCITATION TEMPERATURE AND ELECTRON DENSITY MEASUREMENTS IN TEST SECTION AND PLENUM CHAMBER. Kamimoto, Goro; Shirai, Hiroyuki (Kyoto Univ.). Nippon Koku Gakkaishi, 16: 378-85(Nov. 1968). (In Japanese).

The flow properties in the test section and plenum chamber of arc-heated plasma jet wind tunnel are studied mainly by a spectroscopic technique. Measured properties are electronic excitation, electron temperatures, and electron density, and it

is shown that electronic excitation and electron temperatures do not equilibrate with the heavy-particle temperature. It is demonstrated that the electron density in the plenum chamber is considerably larger than what can be deduced from the electron density in the test section by assuming the frozen isentropic nozzle flow. Rotational temperature of the 2nd positive system (0,0) band of N_2 which is premixed in the argon plasma jet is also measured. (NSA of Japan)

8593 STUDIES OF IONS IN PLASMAS EXCITED AT MICROWAVE AND HIGH FREQUENCIES. Studniarz, Stanley Alexander. Houston, Tex., Rice Univ., 1968. 155p.

Thesis.

The mean energies of the electrons and positive ions in electrodeless plasmas excited at 50 and 2450 Mc were measured by extracting the positive ions and electrons from the plasma into a vacuum (10^{-6} torr) through a hole (0.02-in. diameter) in a metal sampling probe and subsequently subjecting the charged particles to a retarding electric field. A mathematical analysis is presented that relates the integrated translational energy distribution of the electrons and positive ions in the beam issuing from the probe orifice to the energy distribution in the plasma. The electron energy distribution fitted the Maxwellian energy distribution with mean energies of 10 to 25 eV. The mean electron energy decreased with increased pressure. The mean electron energy was independent of the microwave input power to the resonant cavity and position of the visible plasma sampled along the axis of the discharge tube. The experimental positive ion translational energy distribution was found to be displaced from zero by 20 to 80 volts. This range of potential represents the range of plasma-probe potentials. The variation of the plasma-probe potentials and the current flux to the walls of the probe with pressure and power input, and the plasma-probe potentials along the axis of the discharge tube are given. The observed positive ion energy distribution in the plasma in the vicinity of the probe aperture fitted the Maxwellian energy distribution with a mean energy on the order of 0.5 eV. The pressure range was 0.05 to 1.5 torr and the range of input power was 5 to 100 watts. Studies of the extent of ion–molecule reactions in high-frequency plasmas as a function of gas pressure and studies of the relative ionic composition of the plasma as a function of the translational energy of the ions issuing from the orifice of the sampling probe at constant pressure were made by the use of a quadrupole mass spectrometer employing a retarding potential grid system. The results of the study of ion–molecule reactions indicate that the ions collected and observed are formed in a narrow region in the plasma (approximately one mm in depth) in front of the probe orifice and that these ions gain most of their energy from the electric field of the sheath in a distance that is much less than a reaction mean free path (~.01 mm). The average time available for ion–molecule reaction (reaction time) in the plasma was a few tenths of a microsecond and independent of the vessel geometry and dimensions. The reaction time was relatively insensitive to changes in pressure and were reasonably constant for ions in several different gases. An explanation is given in terms of a disturbance to the electric fields of the plasma in the vicinity of the probe aperture. (Diss. Abstr.)

8594 THEORY OF CONDUCTIVITY OF PLASMA MEDIA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Sorokin, N. M. Zh. Eksp. Teor. Fiz., 55: 2200-9(Dec. 1968). (In Russian).

The components of the conductivity tensor in crossed electric and magnetic fields are calculated on basis of the exact solution of the Boltzmann kinetic equation. It is shown that if the relaxation time of the impulse depends on the particle energy, the diagonal component of the conductivity tensor may be larger in a weak magnetic field than in the absence of a field. (auth)

Kinetics

8595 (AEC-tr-7003) INFLUENCE OF INTERELECTRODE DISTANCE ON THE STABILITY OF STRAIGHT PINCH IN A QUADRUPLE HIGH-FREQUENCY FIELD. Morozov, V. E.; Orlinskii, D. V. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated from report IAE-1486. 14p. Dep. CFSTI.

An abstract for the original paper appeared earlier in NSA 22: 46135. (M.O.W.)

8596 (CEA-R-3525) KINETIC EQUATIONS FOR AN UNSTABLE PLASMA. Laval, Guy; Pellat, Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1968. 138p. (In French). (EUR-865). Dep.

The plasma kinetic equations are derived from the Bogolyubov–Born–Green–Kirkwood–Yvon hierarchy of equations. It is demonstrated that relations existing between correlation functions may help to justify the truncation of the hierarchy. Then one obtains the kinetic equations of a stable or unstable plasma. They do not reduce to an equation for the one-body distribution function, but generally involve two coupled equations for the one-body distribution function and the spectral density of the fluctuating electric field. The limiting cases are studied where the Balescu–Lenard equation, the quasi-linear theory, the Pines–Schrieffer equations and the equations of weak turbulence in the random phase approximation are recovered. The H-theorem for the system of equations is generalized and conditions for irreversible behavior are defined. (auth)

8597 (JINR-P9-4041) NONLINEAR LOW-FREQUENCY SPECTRA OF ANISOTROPIC PLASMA OSCILLATIONS. Makhan'kov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 11p. (In Russian). Dep.

Studies were made of the influence of Langmuir high-frequency turbulence on the low-frequency anisotropic plasma oscillations. (tr-auth)

8598 (LA-4015) STATIONARY AXISYMMETRIC FLOW OF A HOT PLASMA. Suydam, B. R. (Los Alamos Scientific Lab., N. Mex.). Oct. 1, 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

A study was made of the axisymmetric flow of a hot plasma, using the magnetohydrodynamic model of Chew, Goldberger, and Low. Certain types of flow are found to produce strong compression and high temperature. The Chew, Goldberger, Low model is shown to predict the same compression, but slightly lower temperature, than does the γ-law ideal gas model. (auth)

8599 (NP-17664) INTERACTION OF MOVING PLASMA WITH AN OBLIQUE MAGNETIC FIELD. Voitsenya, V. S.; Onishchenko, I. N.; Safronov, B. G. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 15p. (In Russian). Dep.

The interaction of a moving plasma cluster in a magnetic trap with the magnetic field, when the plasma moves at an acute angle with respect to the direction of the field, presents an as yet unresolved problem. Such a situation arises when plasma streams are injected into a closed trap, as is the case of the stellarator or a trap with combined fields. The interaction of the plasma with its confining field may be mocked up by the interaction of plasma clusters with an oblique field. The problem was studied by using the drift approximation for analyzing the motion of the plasma in the oblique field; a transverse field applied onto the constant field of the solenoid was used to obtain a magnetic field directed at an acute angle with respect to the direction of the injection. The results indicated that in such an oblique field the plasma diverges from its original direction, creating cut-off plasma clusters. If the duration of the transverse field is reduced, the plasma may be completely occluded, resulting in the absence of probe signals; the calorimetrically determined energy was found to amount to about 0.1 of the energy measured with an applied transverse field. (TTT)

8600 INFINITIES OF THE POWER RADIATED BY A DIPOLE IN AN IONIZED MEDIUM. IRREVERSIBLE AND REVERSIBLE POWER. Lafon, J. P. (Observatoire de Paris, Meudon). Rev. Phys. Appl., 3: 216-22(Sept. 1968). (In French).

The Green's tensor for the case of a collisionless plasma is discussed. The relations which exist between E_{out}, the "outgoing field," and E_{in}, the "ingoing field" are described. These relations correspond to similar expressions for the "outgoing" and "ingoing" tensors $\mathcal{G}_{out}$ and $\mathcal{G}_{in}$. The case of a cold, homogeneous plasma in the presence of a finite (biaxial case) or infinite (uniaxial case) magnetic field is given particular attention. A complete calculation of G_{zz} is done for the uniaxial case. The results and reasoning are compared with those of Lee and Papas (1965 and 1966) and of Staras (1966), and several points of disagreement are found. The regularity of the solutions of the homogeneous wave equation which has been neither contradicted by Staras nor demonstrated by Lee and Papas, is studied. The introduction of collisions into the calculations of the radiated power P is also discussed. Finally, it is shown that the separation of the radiated power into $P_{reversible}$ and $P_{irreversible}$ (as done by Lee and Papas) always leads to: $P_{irreversible} = P_{total}$; $P_{reversible} = 0$. (auth)

8601 THEORY OF PHOTONS IN A FULLY IONIZED GAS. I. PHOTON MOMENTUM DISTRIBUTION. Kwang, In Kil; Grandy, W. T. Jr. (Univ. of Wyoming, Laramie). Phys. Rev., 177: 359-70(Jan. 5, 1969).

The role of the photon momentum distribution and its relation to the thermal radiation spectrum in a fully ionized gas is studied. An analytic continuation of the theory to low-momentum quantum

numbers is developed, which is valid for the nonrelativistic system at high temperature and low density. A mass renormalization is carried out in order to treat the electromagnetic self-energies systematically, after which several new results are calculated for the number density, energy density, and momentum distribution for photons. Leading-order effects due to Coulomb interactions are also found for the thermodynamic functions of the radiation field. Of particular importance is a careful analysis of the dependence of the radiation spectrum on the photon momentum distribution, and this relation is found to be far from straightforward. (auth)

8602 THEORY OF PHOTONS IN A FULLY IONIZED GAS. II. PLANCK'S LAW AND THE DIELECTRIC CONSTANT. Grandy, W. T. Jr. (Univ. of Wyoming, Laramie). Phys. Rev., 177: 371-5(Jan. 5, 1969).

A theory of the radiation spectrum in a nonrelativistic fully ionized gas in thermal equilibrium is suggested, based on Planck's law of radiation. From an observation regarding the photon momentum distribution, an exact and simple dispersion relation for transverse electromagnetic waves in the medium is deduced, and a new dielectric "constant" is obtained. An important feature of the theory is the relative ease with which the thermodynamic functions describing the radiation field can be calculated. (auth)

8603 A QUANTITATIVE INTERPRETATION OF ELECTRON GROUPS IN A BEAM GENERATED He LOW-PRESSURE PLASMA USING BOLTZMANN EQUATION. Franck, Guenter (Univ., Munich). Z. Phys., 218: 460-71(1969). (In German).

Neglecting electron-electron collisions the velocity distribution of plasma electrons in a beam generated He-low pressure plasma is evaluated with help of Boltzmann equation. The energy distribution of secondary electrons generated by the electron beam is considered applying the atom collision theory of Gryzinski. The resulting velocity distribution of plasma electrons shows group character. The "temperatures" of the ultimate and secondary electrons and their density ratio are in satisfying agreement with experiment. (auth)

8604 INVESTIGATION OF PLASMA ROTATION IN A PULSED INDUCTIVE ACCELERATOR. Dailey, C. L. (TRW Systems Group, Redondo Beach, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 13-19(Jan. 1969).

An experimental investigation of the plasma properties in the accelerating current layer of a pulsed inductive plasma accelerator is described. Current from an initially charged capacitor passing through a flat spiral coil produces ionization and snowplow acceleration in argon at 1-torr pressure and room temperature without preionization. The plasma current layer forms in a thin disk increasing in intensity to a maximum of about 15 ka/cm^2 after 0.2 μsec. It then splits into two layers of reduced amplitude, producing a rounded shoulder on the corresponding magnetic field distribution. The plasma motion is calculated from electron density and electric and magnetic field measurements. There is an azimuthal velocity component showing that ions carry a substantial fraction of the total current in both of the current layers. The axial motion represents a kinetic energy on the order of 40% of the work done on the plasma by the accelerator coil during the first 0.6 μsec of the first quarter-cycle at an average I_{sp} of 1500 sec. (auth)

8605 ELECTRODYNAMICS OF TURBULENT MOTIONS IN CONDUCTING MEDIA. PART II. TURBULENCE-CONDITIONED CONDUCTIVITY AND PERMEABILITY CHANGES. Raedler, K.-H. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Z. Naturforsch., 23a: 1851-60(Nov. 1968). (In German).

In the foregoing paper the foundations for an electrodynamics of mean fields in turbulently moving electrically conducting media were developed. With the method demonstrated there, a special case is treated here. The turbulence is supposed to deviate from a homogeneous isotropic one showing reflection symmetry, only due to a gradient of intensity, i.e., of the mean square velocity. The calculations are carried out for small intensities. As a result, expressions for the modified conductivity introduced for homogeneous turbulence in the foregoing paper are given and discussed. The effect of the intensity gradient is illustrated by a simple example. Furthermore, a possibility of describing the general result in terms of modified conductivity and permeability is shown. (auth)

8606 ELECTRODYNAMICS OF TURBULENT MOTIONS OF CONDUCTING MEDIA. PART I. PRINCIPLES OF ELECTRODYNAMICS OF AVERAGE FIELDS. Raedler, K.-H. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Z. Naturforsch., 23a: 1841-51(Nov. 1968). (In German).

The behavior of electromagnetic fields in electrically conducting media under turbulent motions is discussed. The basis is formed by Maxwell's and corresponding constitutive equations, including Ohm's law, neglecting the usual things in MHD. Attention is directed to certain mean fields defined by statistical averaging. From the equations mentioned above, except Ohm's law, one gets equations of the same kind for the mean fields. In Ohm's law, however, the transition to the mean fields leads to an additional term $\overline{v'} \times \overline{B'}$, the averaged vector product of the fluctuations in the velocity of the medium and the magnetic flux density. The investigation of this term makes up the center in the elaboration of an electrodynamics of mean fields. As a very simple example, a homogeneous isotropic turbulence showing reflection symmetry is considered. In this case $\overline{v'} \times B'$ makes allowance for the introduction of a modified electrical conductivity. If the reflection symmetry is violated, $\overline{v'} \times \overline{B'}$ describes an effect allowing a dynamo action. Furthermore, a general method for calculation of $\overline{v'} \times B'$ for arbitrary turbulent motions is developed, and a survey is given of the results which can be expected for some special kinds of turbulence. (auth)

8607 TEMPERATURE DEPENDENCE OF DISSOCIATIVE RECOMBINATION AND MOLECULAR-ION FORMATION IN He, Ne, AND Ar PLASMAS. Chen, Che Jen (California Inst. of Tech., Pasadena). Phys. Rev., 177: 245-54(Jan. 5, 1969).

Recombination-dominated decaying plasmas in He, Ne, and Ar gases are produced in a discharge tube energized with a capacitor bank capable of delivering 3×10^3 J at 20 kV. The electron temperature, atom temperature, and electron number density as a function of time are measured by using a triple probe, a thin-film thermometer, and the triple probe and microwave apparatus, respectively. The atomic- and molecular-ion number densities are monitored by using a mass spectrometer. The electron-temperature dependence of the dissociative recombination coefficient α_2, and the atom-temperature dependence of the molecular-ion formation coefficient γ are calculated. The results indicate the following: (1) the electron-temperature dependence and absolute value of α_2 are both affected by the atom temperature of the plasma; a simplified physical model is proposed to explain this variation of dependence; the previous controversial experimental results published in the literature on this subject can be understood with the use of this physical model; and (2) the atom-temperature dependence of γ agrees with theoretical expectations. (auth)

8608 COLLISIONAL-RADIATIVE RECOMBINATION OF IONS AND ELECTRONS IN HIGH-PRESSURE PLASMAS IN WHICH THE ELECTRON TEMPERATURE EXCEEDS THE GAS TEMPERATURE. Collins, C. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 177: 254-7(Jan. 5, 1969).

The recombination rate of electrons in a hypothetical helium-like plasma at high pressure is calculated for cases in which the gas temperature is fixed at 300°K, and the electron temperature is varied from 300 to 2000°K. Neutral collision-induced recombination and electron collision-induced recombination are considered for ranges of electron density from 10^5 to 10^{13} cm^{-3} and gas densities from 10^{16} to 10^{19} cm^{-3}. An inverse three-halves dependence of recombination coefficient on electron temperature is found for certain densities. (auth)

8609 LATE-TIME SOURCE OF ATOMIC LIGHT IN THE HELIUM AFTERGLOW. Collins, C. B.; Hurt, W. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 177: 157-62(Jan. 5, 1969).

The time-dependent behavior of the light emitted from a pulsed helium afterglow at 3 torr has been investigated with an improved spectrometric system of sufficient sensitivity–bandwidth ratio to resolve the behavior of the atomic light over a 50-msec time interval. The relationship between the atomic light and the time-resolved electron density, as measured with a 36-GHz free-space microwave interferometer, was found to indicate the importance of a persistent source of ionization at late times. Absorption measurements of time-dependent behavior of both the atomic 2^3S and molecular $2^3\Sigma$ metastable species were found to strongly favor mutual ionization of two metastable molecules as being the most important source of late-time ionization at 3 torr. (auth)

8610 THEORY OF WAVES IN INHOMOGENEOUS WARM PLASMAS. de Almeida Azevedo, J. C.; Vianna, Marcio L. (Pontificia Univ. Catolica, Rio de Janeiro). Phys. Rev., 177: 300-5(Jan. 5, 1969).

A theory is developed for the behavior of waves in a warm inhomogeneous plasma in the presence of a magnetic field perpendicular to the density gradients of the unperturbed plasma. The full set of the Maxwell–Vlasov equations is solved by use of perturbation methods. The theory is valid for arbitrary directions of wave propagation and both for strong as well as for weak magnetic fields, including zero. It is shown that this theory possesses as limiting cases previously derived results, and, as an example of the theory, a quantitative analysis of the O'Brien, Gould, and Parker experiment is worked out. (auth)

8611 EQUILIBRIUM THEORY OF A PARTIALLY IONIZED PLASMA. Jackson, Julius L.; Klein, Lewis S. (Howard Univ., Washington, D. C.). Phys. Rev., 177: 352-8(Jan. 5, 1969).

A detailed study is made of the use of the Debye potential as the effective interaction between the electron and proton of a hydrogen atom in a partially ionized plasma. The chemical potentials of the constituents are calculated and examined in the light of the requirement that they be consistent with a single free-energy function. On this basis a Saha equation is derived, which is consistent and correct up to terms of the order of the Debye–Hückel energy. It is further shown that the next order, obtained by expanding the effective potential in powers of the Bohr radius divided by the Debye length, is incorrect. (auth)

8612 MAGNETIC INTERACTIONS IN A WARM PLASMA. Krizan, John E. (Univ. of Vermont, Burlington). Phys. Rev., 177: 376-80(Jan. 5, 1969).

A comparison of several kinetic equations with electromagnetic interactions is made. In particular the effects of assuming the Darwin Hamiltonian are investigated, and it is concluded that the role of the magnetic forces may be of importance in the stability problem, since they seem to manifest tendencies opposite to those of the electrostatic forces in the limiting cases of long and short wavelengths. The possibility of the existence of density waves at or close to equilibrium, due to the presence of the $(v/c)^2$ interactions, is pointed out. Transport calculations will lead to the same results as those in the calculations of Trubnikov, although it may be expected that if cutoffs are eliminated as in previous work, the results will differ. (auth)

8613 PINCHED SOURCE OF IONIZED CLUSTERS FOR AEROPHYSICAL INVESTIGATIONS AT HIGH PRESSURES. Balyberdin, V. V.; Gurov, V. M.; Papkovich, V. G. Samoletostr. Tekh. Vozdush. Flota, No. 5, 77-81(1966). (In Russian).

A pinched source of ionized clusters for aerophysical investigations at high pressures was developed. The jet plasma characteristic of the source was studied, and the experimental results are shown graphically. The developed source was used in the study of the stabilization of ion clusters after the method of G. A. Askar'yan (Zh. Tekh. Fiz., 31: 1038(1961)) and in the study of alternating-current flow through eddies of ionized gas. The performance of the source was found to be satisfactory. (ATD)

8614 VARIATIONS IN THE INTENSITY AND OUTLINE SHAPE OF SPECTRAL LINES RESULTING FROM THE BREAKDOWN OF THE MAXWELLIAN ENERGY DISTRIBUTION. Preobrazhenskii, N. G.; Shaparev, N. Ya. (Novosibirsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 89-91(1968). (In Russian).

Deviation from the Maxwellian energy distribution of the plasma, resulting from the depletion of fast electrons, reduces the overall electron density. Changes in the "tail" of the distribution curve influences unevenly the shock ionization by electrons and the radiative recombination processes. A simple correlation was derived for examining the outline and the total intensity of resonance lines, determining the effect of the tail on the excitation and quenching mechanisms. The calculations indicated that in the case of Maxwellian distribution, the source function has a lesser gradient and the shape of the line is less uniform while the intensity of the line is at maximum if differences in the electron concentration are neglected, the partial results published some time ago by S. Cuperman, are obtained. (TTT)

8615 BEHAVIOR OF THE COMPLEX REFRACTIVE INDEX OF AN ISOTROPIC PLASMA. Habert, R.; Samaddar, S. N. (Raytheon Co., Sudbury, Mass.). Amer. J. Phys., 36: 1117-22(Dec. 1968).

A study was made of the behavior of the real and imaginary parts of the complex refractive index of a homogeneous isotropic plasma. The independent variable is either $x = \nu/\omega$ or $y = (\omega_p/\omega)^2$ while the other quantity y (or x) is considered to be a parameter and held constant. It is shown that both the real and the imaginary parts of the refractive index may possess extrema. They are maxima when x alone is varied while they may be minima when y alone is varied. The present investigation supplements the work of Ratcliffe. (auth)

8616 MICROWAVE CONDUCTIVITY IN A TURBULENT PLASMA WITH A MAGNETIC FIELD. Takeda, Susumu; Tsukishima; Hattori, Chyutetsu; Horio, Toshimasa (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1522(Nov. 1968).

Experimental measurements of effect collision frequencies in PIG discharges are described. They were deduced from the ratio of the microwave conductivity to the electron density. (M.O.W.)

8617 DETERMINATION OF THE IONIC COMPOSITION OF AN ARC-DISCHARGE PLASMA IN CESIUM VAPOR. Morgulis, N. D.; Korchevoi, Yu. P. (Kiev State Univ.). JETP Lett. (USSR) (Engl. Transl.), 8: 192-4(Sept. 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 313-15(Sept. 20, 1968).

A direct method of mass-spectrometric analysis was used for studying the ion composition in an arc-discharge plasma in cesium vapor at different pressures. An integrally sealed glass instrument consisting of two sections was constructed: (1) an arc-discharge tube provided with a probe for the determination of the density n_e and the temperature T_e of the electrons of the investigated plasma, and (2) a time-of-flight mass analyzer with an electron multiplier on the inside and an Si-17 oscilloscope at the output. Results of the ionic composition are described. (M.O.W.)

8618 ACCELERATION OF PLASMA IN A CONICAL INDUCTION SOURCE. Churaev, V. A.; Khizhnyak, N. A.; Safronov, B. G. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 395-7(Feb. 1968). (In Russian).

It is theoretically shown that if the plasma accelerated in a conical induction accelerator is represented as a flexible current loop, then there can exist a loop and cone configuration such that the loop current is equal to zero. Consequently the loop is not acted upon by the accelerating field. Such a loop position is a position of stable equilibrium that moves along the inductor axis. To check whether a loop with finite mass equal to the plasmoid mass can move at the same velocity as the equilibrium point, the authors solved the appropriate system of equations by means of an electronic computer, which verified this possibility, and measured the velocities of plasmoids under different conditions in an inductor. All the experimental points fitted the theoretical curve quite well. The results show also that, depending on the time delay between the instant of admission of the gas and the switching of the inductor battery, the plasmoid may either leave the inductor during the same half-cycle at which the gas breakdown occurred, or else during the beginning of the next half-cycle. In the latter case, there is no acceleration during the first half-cycle. This also agrees with the experimental data. (ATD)

8619 TRANSPORT THEORY AND CORRELATION FUNCTIONS WITH COULOMB INTERACTIONS. Cheng, Chiang-shuei. Bethlehem, Pa., Lehigh Univ., 1968. 126p.

Thesis.

The statistical theory connecting space- and time-dependent correlation functions and linearized hydrodynamics is developed for a system with Coulomb interactions, such as a fully ionized gas. The method used is a perturbation technique recently developed by McLennan, which is based on the Onsager assumption on the regression of fluctuations whereby the correlation functions are separated into slow hydrodynamic and rapid microscopic parts. The internal Coulomb interactions among the charges of the system induce long-range equilibrium correlations, and the matrix of equilibrium density–density correlation functions is singular for vanishing wavenumber k because of overall charge neutrality of the system. In consequence, there is a hydrodynamic mode, corresponding to charge relaxation, whose relaxation time remains bounded for $k \to 0$. The transport coefficients are found to be related to the microscopic parts of correlation functions in much the same way as for neutral systems. However, in contrast to the neutral case, the hydrodynamic parts of some flux–flux correlation functions do not vanish for $k = 0$ because of the finite charge relaxation time. For example, the hydrodynamic part of the electric current–current correlation function is nonvanishing for $k = 0$. Therefore, the usual electrical conductivity formula, such as Kubo's, must be interpreted as referring only to the microscopic part, rather than the total current–current correlation function. (Disser. Abstr.)

8620 DIFFRACTION BY A WEDGE IN AN ANISOTROPIC MEDIUM. Roseau, M. Arch. Ration. Mech. Anal., 26: 188-218(1967).

The problem of diffraction of electromagnetic waves propagating in an anisotropic magnetoactive plasma by a wedge with perfectly conducting walls under the action of a constant magnetic field parallel to the axis of the wedge is considered. It is shown that from a mathematical point of view the problem is equivalent to another one which arises when one discusses diffraction of tidal waves by a wedge, with the additional assumption that the frame of reference is rotating with a constant angular velocity parallel to the axis of the wedge. An explicit solution of the latter problem is built up where a plane incoming wave at infinity is given. The behavior of the solution near the origin and its asymptotic behavior at infinity are also studied. (App. Mech. Rev.)

8621 FLUCTUATIONS IN MULTIPOLE CONFINED PLASMAS. Coppi, B. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett., 22: 50-4(Jan. 13, 1969).

An explanation is given for different types of fluctuations

observed in multipole experiments based on a new formal solution of the general integral equation that yields, besides the known hydromagnetic mode types, modes with frequency smaller than the average ion slow-excursion frequency. The relevant modes are of flute type, have frequency range and phase velocity in agreement with observation, and become almost purely growing and unlikely to be observed as fluctuations in conditions where these have not been detected. (auth)

8622 BOSE CONDENSATION AND SHOCK WAVES IN PHOTON SPECTRA. Zeldovich, Ya. B.; Levich, E. V. (Inst of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2423-9(Dec. 1968). (In Russian).

The process of establishment of equilibrium in a system consisting of radiation and a totally ionized plasma is investigated. The solution of the kinetic equation shows that in the absence of absorption Bose condensation of photon occurs. The course of the process significantly depends on the form of the initial distribution. For a certain initial shape of the spectrum subsequent evolution leads to the formation of a shock wave in the spectrum. Absorption substantially affects this process, Bose condensation being replaced by temporary accumulation of photons in the low-frequency range. (auth)

8623 CONTRIBUTION TO THE THEORY OF FLUCTUATIONS AND SCATTERING OF WAVES IN A PLASMA LOCATED IN STRONG ELECTRIC AND MAGNETIC FIELDS. Akhiezer, I. A.; Angeleiko, V. V. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz., 55: 2291-7(Dec. 1968). (In Russian).

Fluctuations and scattering of electromagnetic waves in a partially ionized plasma located in strong electric and magnetic fields are studied. It is shown that for a strong magnetic field the fluctuation correlators have sharp maxima at frequencies of the magnetosonic oscillations. As the external electric field strength E_0 approaches a certain value E_c, the intensity of fluctuations with wave vectors lying in semi-space $\chi < \pi/2$ sharply rises (in contrast to the case previously considered of a weak magnetic field, in which case a sharp rise of the fluctuations occurred only for $\chi \ll 1$ where χ is the angle between the wave vector of the fluctuation and the mean direction of the electron velocity v_0). When an electromagnetic wave moves through a plasma, sharp peaks appear in the scattered radiation spectrum which are displaced from the primary line by the frequency of the magnetosonic wave (magnetosonic satellites). For $E_0 \to E_c$ the intensity of the satellites sharply increases for scattering into a cone $\theta' > \theta$ and the integral scattering cross section grows as $(E_c - E_0)^{-1}$ (in contrast to the case of a weak magnetic field for which the satellite intensity sharply increases only for scattering into a definite direction and the integral scattering cross section grows logarithmically; $\theta(\theta')$ is the angle between the wave vector of the incident (scattered) wave and v_0). Thus critical fluctuation and critical opalescence phenomena are more pronounced in the case of a strong magnetic field than in the case of a weak magnetic field. (auth)

8624 PERTURBATION OF A MEDIUM BY A STRONG ELECTROMAGNETIC WAVE. Gorbunov, L. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2298-2309(Dec. 1968). (In Russian).

A dispersion equation describing the low-frequency perturbation spectrum in a transparent medium (plasma or liquid) traversed by a pumping electromagnetic wave is derived. It is shown that for wave amplitudes exceeding a certain critical value the concept of weakly coupled sound and electromagnetic perturbations becomes meaningless. In these conditions, it follows from the dispersion equation that the initial density perturbations aperiodically increase in time. (auth)

8625 A STUDY OF LOW-FREQUENCY OSCILLATIONS IN A RAREFIED MAGNETOPLASMA. Block, Joseph Leon. Columbus, Ohio, Ohio State Univ., 1968. 110p.
Thesis.

Oscillations in a low-density cylindrical plasma column suspended in a magnetic field were studied and were found to involve fluctuations of potential propagating in the azimuthal direction transverse to the magnetic lines of induction. The plasma was formed by the ionization of neutral gas molecules within a column of electrons trapped between an electron gun and a reflecting electrode. The initial electron column was 0.6 cm in diameter, but an anomalously high plasma radial transport rate resulted in a substantial plasma density at a distance up to 3 cm from axis of the chamber. The net charge concentration within the column could be adjusted by changing the background gas pressure which was varied from 10^{-7} to 10^{-4} torr. Both air and argon were used as background gases in this work. At low background pressures uncompensated negative space charge resulted in an inwardly directed radial electrostatic field which caused the plasma column to rotate, with particles moving azimuthally at the drift velocity: $v_D = (E \times B/B^2)$. By changing the electric field both by means of pressure adjustments and by changing the bias applied to the electron gun, the rate of rotation could be varied and the velocity of propagation of the wave could be separated from the drift rotation of the plasma. The oscillation frequency was found to vary inversely with B, and was found to be compatible with that predicted for a drift wave: $\omega = k(kT_e/B)(dn/dr)(1/n_e)$ where k is the wave number, n_e the electron density, k Boltzmann's constant, and T_e the electron temperature. Probe measurements revealed T_e to be generally between 10 and 25 eV and electron densities to be about $10^7/cm^3$. Studies in the region where the ion–cyclotron and drift-wave frequencies were comparable confirmed the prediction of Mikhailovskii and Timofeev that a plasma can be unstable to high-frequency drift waves under the prevailing conditions. At the ion cyclotron frequency a change in behavior of the frequency vs 1/B plots was observed. The amplitude of the disturbance was found to attenuate with rise in frequency in the high-frequency region. Attenuation also resulted as the length of the plasma column was decreased from 36 to 18 cm, in agreement with the theory for the drift-wave branch of the universal instability. The rate of transport of plasma transverse to magnetic induction lines was found to be several orders of magnitude higher than that predicted by classical collisional diffusion. The observed rate was of the same order of magnitude as that expected on the basis of the Bohm "drain diffusion" process. (Diss. Abstr.)

8626 TRAPPED MODES IN PLASMA SLABS AND CYLINDERS. Weil, Antoine Julien. University Park, Pa., Pennsylvania State Univ., 1968. 152p.
Thesis.

An analysis of trapped modes is given for uniform, cold magnetoplasma slabs and rods. The full set of Maxwell's equations is used, and arbitrary magnetic field strength is allowed. Two dispersion relations are obtained for the slab, characterizing symmetric and antisymmetric field solutions. The general dispersion relation for the plasma rod geometry is obtained, simplified using an analogy with the slab case, and analyzed. For each dispersion relation, three kinds of interior waves are found: (1) waves which damp as you move toward the center; (2) oscillating or body waves; and (3) damped oscillating waves. The field characteristics of the waves are analyzed for the slab geometry and for the dipolar modes of the plasma rod. A new approximation, the "one wave" approximation is introduced and discussed. Dispersion curves and field solutions are given for $\Omega = .5\omega_p$ and $\Omega = 1.5\omega_p$, and for different thicknesses. (Diss. Abstr.)

8627 COLLECTIVE VARIABLES IN A TWO-COMPONENT PLASMA. Vavrukh, M. V. Visn., L'viv. Derzh. Univ., Ser. Fiz., No. 3, 26-33(1968). (In Ukrainian).

An analysis was made of the statistical sum of the quanta of an equilibrium plasma consisting of ions and electrons, using the collective-variable method. Explicit equations are given for the potentials of high-temperature two-fermion interactions. Also derived are formulas for electron–electron interactions, for the free energy of such a plasma, in the form of the sum of virial coefficients, and for the quantum screening potentials. (IAA)

8628 RELATIVISTICALLY INTERSTREAMING BOUNDED PLASMA INTERACTIONS. Martin, Gayle Patrick. Austin, Tex., Univ. of Texas, 1968. 141p.
Thesis.

The characteristic equation has been formulated and some of its solutions are presented in the form of dispersion diagrams for a circular cylindrical waveguide loaded with several concentric regions of plasma interstreaming at relativistic velocities along the guide axis; the axis is aligned with an externally applied "dc" magnetic field. The small signal approximation was used in the derivation of the characteristic equation, but the quasi-static approximation was not used, and relativistic terms were retained. The plasma components display no thermal effects except through a collision frequency representing collisions in which all of the particle's "ac" momentum is lost. The dispersion diagrams presented, which were obtained through use of a CDC 6600 computer, represent a variety of electron beam interactions with an electron–ion plasma for modes with no angular variation; some stationary plasma data are also presented. The interactions of an electron beam's fast and slow space charge and cyclotron modes with the first and second plasma cyclotron and space charge modes were calculated for a variety of combinations of beam density, radial size, and velocity. The beam radius varied from 0.01 to 1.0 times the waveguide radius, while beam plasma frequency was as small as 0.001 and as large as 0.1 times the stationary plasma frequency, and beam velocity ranged from 0.02 to 0.90 times the speed of light. The stationary plasma which filled the waveguide was composed of electrons, and either hy-

drogen ions, deuterium ions, a hypothetical ion with proton charge and nine times the mass of an electron, or a combination of these particles, while plasma losses expressed as a ratio of collision frequency to the plasma frequency ranged from 10^{-7} to 10^{-3}. For all of the dispersion curves presented, the ratio of electron cyclotron frequency to electron plasma frequency was constant at 0.5 while the ratio of waveguide radius times the speed of light to the electron plasma frequency was constant at 4.0. Graphs of the electromagnetic fields and the Polynting vector versus radius were obtained for a number of modes involved in these interactions. Attempts have been made to identify regions of the dispersion curves representing convective and absolute instabilities and to calculate the growth rate of amplifiers or the starting length of oscillators utilizing these interactions. The nature of the interaction between higher order beam modes and higher order plasma modes for the beam totally and partially filling the waveguide was novel and had not been anticipated by the author through the use of coupled mode theory. (Diss. Abstr.)

8629 APPARENT NONLINEAR DAMPING OF ION–ACOUSTIC WAVES. Doucet, H. J.; Gresillon, D. (CNRS, Paris). Phys. Lett., 28A: 257-8(Dec. 2, 1968).

When an ion–acoustic wave is excited by a grid immersed in a plasma a fast component appears and is mixed with the wave. The result looks like a nonlinear collisionless damping. (auth)

Production

8630 (BMwF-FBK-68-29) INVESTIGATIONS OF STRONG SHOCK-WAVES. (STATUS: DECEMBER 1967). Berge, O. E.; Boetticher, W.; Carls, H.; (and others) (Kiel Univ. (West Germany). Institut fuer Experimentalphysik). July 1968. 62p. (In German). Dep.

The status is reported of investigations of plane (membrane shock tube, $M \leq 15$) and convergent cylindrical shock waves (Z pinch, $M \leq 100$) and the connected diagnostic methods. The electron density is determined by optical and microwave interferometers. The shock-front velocity is measured by a laser–schlieren method and by the Doppler effect of microwaves. Finally, different methods for the calculation of the partition function of diatomic molecules are compared. (auth)

8631 THEORETICAL STUDY OF THE IONIZATION OF DEUTERIUM UNDER THE ACTION OF A SHORT PULSE LASER. Canto, Christian; Reuss, Jean-Daniel; Veyrie, Pierre (CEA, Val-de-Marne, France). Compt. Rend., Ser. A and B, 267: 878-81(Oct. 21, 1968). (In French).

The modes of evolution and creation of plasma obtained by means of a laser in gases were studied. It was shown that in addition to a hydrodynamic evolution by detonation wave, opacification phase waves of the medium by multiphotoelectric absorption and bremsstrahlung can also be produced. It was verified that these theories agree with experiments. (tr-auth)

Stability

Refer also to abstracts 8500 and 8572.

8632 (LA–4034) STABILITY OF SLOWLY TAPERED AXISYMMETRIC PLASMA FLOWS. Suydam, B. R. (Los Alamos Scientific Lab., N. Mex.). Nov. 5, 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

In experiments with a coaxial plasma gun, Marshall and others have observed what appears to be a steady flow of plasma accompanied by strong compression on the axis. Morozov and others have described theoretically steady axisymmetric flows which seem very similar to those observed. Analytic results are achieved by assuming the electrodes to be gradually tapered. The magnetohydrodynamic stability of such flows is discussed. The assumption of gradually tapered electrodes enables one to develop a variational technique. It was found the m = 0 mode generally to be unstable or stable accordingly as there is or is not shear in the flow. Kink (m = 1) modes are unstable. (auth)

8633 ENHANCED FLUCTUATIONS IN A MAGNETIZED PLASMA DUE TO A DEGENERATE ION-WAVE INSTABILITY. Wu, Ching-sheng; Zmuidzinas, Jonas Stasys (California Inst. of Tech., Pasadena). Phys. Rev., 177: 408-12(Jan. 5, 1969).

A nondispersive low-frequency mode is shown to exist in a magnetized plasma with frequencies much lower than the ion cyclotron frequency. This mode may be viewed as a degenerate ion acoustic mode. The condition for its existence is that the longitudinal electron-to-ion temperature ratio be much greater than unity. In the presence of electron drift relative to the ions and parallel to the magnetic field, the plasma may become unstable if the drift speed exceeds a certain critical value. In the stable region the electric field fluctuations can become greatly enhanced when the drift speed is close to the phase velocity of the wave. Since the wave is nondispersive, the enhancement occurs for a wide range of wave numbers. (auth)

8634 COLLISION-INDUCED INSTABILITY AT CYCLOTRON HARMONICS. Shimomura, Noboru; Mitani, Kenji (Kyoto Univ.). J. Phys. Soc. Jap., 25: 1467-74(Nov. 1968).

The collision-induced instability at the cyclotron harmonics of the ordinary wave is studied under an assumption $\nu(V) \propto V^h$, where ν is the electron collision frequency with neutral particles and V the electron velocity, respectively. When the initial distribution of the electron velocities is a spherical shell in velocity space, it is found that the large values of μ = (Larmor radius) × (wave number) relax the restriction of h which leads to the instability and the condition h = 3 is sufficient to generate the instability at the higher cyclotron harmonics if μ is chosen suitably. Furthermore, the growth rate increases with the electron density for given ν and h, and it attains the maximum at $\omega_p \gtrsim \omega_c$, where ω_p and ω_c are the plasma and the cyclotron frequencies, respectively. (auth)

8635 NONLINEAR THEORY OF COLLISION-INDUCED INSTABILITY OF PARTIALLY IONIZED GASES IN EXTERNAL MAGNETIC FIELD. Suzuki, Kunihiro (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1474-84(Nov. 1968).

Nonlinear characteristics of the collision-induced instability of partially ionized gases which have a large Ramsauer effect are investigated. Right-handed polarized waves propagating along the external magnetic field are considered. Calculations are made on the nonlinear interactions between waves of different wave numbers, using the assumption that the velocity distribution function of electrons stays a delta function in the course of time. The results show that in contrast to the nonlinear Landau damping of plasma waves where the energy flow is directed toward the region of small k, in the present case the wave energies transfer toward the lower frequency side as seen from the coordinate system rotating with the gyrating electron. (auth)

8636 BURST OF HOT ELECTRON IN A MICROINSTABILITY. Shiina, Shoichi; Ohnishi, Haruyuki; Hosokawa, Minoru; Ikezi, Hiroyuki; Tanaka, Shigetoshi; Ikegami, Hideo (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1520(Nov. 1968).

It was earlier reported that the hot electron plasma in the TPM machine became unstable after the microwave power was turned off and that the instability was accompanied with a burst of light, a fast-rising x-ray signal, a sudden decrease of electron density, and an intense microwave burst. In order to study the characteristics of the instability, the energy of hot electrons escaping along the magnetic force lines was measured; these measurements are briefly discussed. (M.O.W.)

8637 PLASMA INSTABILITY IN A STRONGLY INHOMOGENEOUS MAGNETIC FIELD. Gordeev, A. V.; Rudakov, L. I. Zh. Eksp. Teor. Fiz., 55: 2310-21(Dec. 1968). (In Russian).

Nonpotential electron oscillations of a plasma with a frequency $eH/m_ic \ll \omega \ll eH/m_ec$ in a strongly inhomogeneous magnetic field are investigated. Instabilities of a nonlinear magnetosonic wave in a rarefied plasma are considered. It is shown that a front of width δ which is smaller than c/ω_{pi} may be unstable with respect to perturbations of the "whistler" type of dimension δ. These instabilities develop during a period of time which is smaller than the steepening time of the nonlinear wave and should prevent the formation of a front with a width smaller than c/ω_{pi}. It is also shown that the front of nonlinear magnetoacoustic wave with a width smaller than $(m_i/m_e)^{1/2}c/\omega_{pe}$ may be unstable with respect to high frequency, $\omega > eH/(m_im_e)^{1/2}c$ perturbations with kH = 0. (auth)

8638 DRIFT INSTABILITY OF A COLLISIONLESS PLASMA IN A HIGH-FREQUENCY E-WAVE FIELD. Demirkhanov, R. A.; Gutkin, T. I.; Lozovskii, S. N. Zh. Eksp. Teor. Fiz., 55: 2195-9(Dec. 1968). (In Russian).

Stability with respect to drift oscillations of a collisionless inhomogeneous plasma located in a strong stationary magnetic field H_0 and in a high-frequency E-wave field is considered. It is shown that for a certain range of high-frequency field strengths and frequencies the field enlarges the stability region and decreases the instability increments. (auth)

8639 THEORETICAL AND EXPERIMENTAL INVESTIGATION OF PLASMA FLUTE MODES IN A NONUNIFORM ELECTRIC FIELD. Kent, Gerald I. New York, City Univ. of New York, 1968. 109p.

Thesis.

The flute mode in a plasma with nonuniform electric fields is studied experimentally and theoretically. Experiments were performed with low-beta alkali metal plasmas produced in a Q ma-

chine. The flutes propagate azimuthally and have maximum amplitude near the plasma column edge where a large radial electric field, E_r, exists. The $E_r \times B$ drift velocity produces an instability similar to the Kelvin–Helmholtz instability. A solution to a differential equation including finite Larmor radius effects, formulated by Rosenbluth and Simon, is presented. Consideration of adjacent regions undergoing rigid-body rotations and having constant density leads to an expression for the oscillation frequencies and a stability criterion. Theoretical results show that velocity shear is the mechanism which drives the instability, but centrifugal effects are also destabilizing. Finite Larmor terms stabilize short wavelengths as for the gravitational flute instability. If the experiment is interpreted in light of the present theory, the oscillation frequencies, stability conditions, and radial amplitude distributions compare favorably. (Diss. Abstr.)

8640 STABILITY OF A MAGNETOACTIVE PLASMA WITH A MONOENERGETIC COMPONENT. Belikov, V. S.; Kolesnichenko, Ya. I.; Oraevskii, V. N. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz., 55: 2210-12(Dec. 1968). (In Russian).

The investigation of stability of a magnetoactive plasma with a small quantity of fast monoenergetic ions is continued. It is shown that a plasma containing an arbitrarily small amount of fast ions is unstable with respect to buildup of Alfvén oscillations. On the other hand the presence of fast monoenergetic ions does not affect significantly the plasma stability at drift frequencies. (auth)

Shielding

Refer also to abstracts 8869 and 8870.

8641 (SC-RR-68-659) COMPARISON OF SELECTED EXPERIMENTAL AND THEORETICAL PHOTON TRANSPORT RESULTS. Renken, James H. (Sandia Labs., Albuquerque, N. Mex.). Oct. 1968. 47p. Dep. CFSTI.

Photon transport calculations have been performed in order to compare results with data obtained in three recent shielding-type experiments. The Monte Carlo and discrete ordinates methods were used; comparisons of results from the two methods are discussed. Some x-ray-scattering data permit a clear assessment of the need to use the coherent–incoherent description of the scattering process, as opposed to the less-refined Klein–Nishina formula, in theoretical calculations. In general, the agreement between theory and experiment is good. Where discrepancies do exist, they can almost always be attributed to known shortcomings in calculations or difficulties with the experiments. (auth)

8642 S_n CALCULATION OF HIGHLY FORWARD PEAKED NEUTRON ANGULAR FLUXES USING ASYMMETRICAL QUADRATURE SETS. Cerbone, R. J.; Lathrop, K. D. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 139-41 (Jan. 1969).

Calculations were performed for the neutron angular distribution at deep penetration from a small spherical fission source in water using the DTF-IV 1DF computer code modified to permit the use of asymmetric quadrature sets. (J.W.R.)

8643 FAST-NEUTRON BIOLOGICAL DOSE ATTENUATION BY LEAD AND POLYETHYLENE SHIELDS. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 6: 63-7 (Jan. 1969).

A method is presented that uses high-order S_n transport in simple geometry to derive an effective removal cross section suitable for point-kernel design calculations. The method involves calculating the fast neutron biological dose at various spatial points in a hydrogenous shell surrounding metal spheres of various radii and then finding exponential functions to represent the attenuation of the metal for parametric thicknesses of the hydrogenous material. Specific calculations were performed for lead and polyethylene, with a Po : Be source, using one-dimensional S_8 calculations with an anisotropic angular quadrature biased toward the forward direction. Multitable thirty-group cross sections with P_3 anisotropic scatter were used for all materials. Results for finite and essentially infinite polyethylene thicknesses were compared; the effect of backscatter on the effective removal cross section is negligible (<1%). The resulting removal cross section was fit by a simple analytical expression within 1.4% for polyethylene thicknesses between 3 and 41 cm. Removal cross sections were derived for lead thicknesses between 0 and 60 cm, but probably are applicable beyond 60 cm. The asymptotic value of the calculated removal cross section is well within the experimental error of the published value for a fission spectrum. The method is not restricted to any particular source spectrum, hydrogenous material, or attenuating material, as has been shown in test calculations for a Ra : Be source and for water, as well as by subsequent successful employment of the method by others for a fission spectrum and in iron shields. (auth)

8644 GAMMA-RAY TRANSMISSION THROUGH INHOMOGENEOUS LAYERS. Hinman, G. W. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 113-17(Jan. 1969).

Experiments have been carried out to determine the difference between gamma-ray absorption in an inhomogeneous layer of material, composed of spherical heavy metal particles (tungsten) in a nonabsorbing matrix, and absorption in a uniform heavy metal sheet of the same average thickness. The results can be used to evaluate a function describing the distribution of absorber thickness at different points on the layer. The gamma rays used ranged in energy from 35 to 122 keV. (auth)

Solid-State Physics

Refer also to abstracts 7762, 7895, 7905, 7924, 8106, 8155, 8300, 8539, and 8548.

8645 (CONF-681020-(Vol.1)) PROCEEDINGS OF THE SEVENTH RARE EARTH RESEARCH CONFERENCE, CORONADO, CALIFORNIA, OCTOBER 28-30, 1968. VOL. I. SESSIONS A THROUGH H. (International Harvester Co., San Diego, Calif. Solar Div. National Science Foundation, Washington, D. C.). 438p. CFSTI.

Thirty-six papers and seven abstracts of papers are presented. Chemistry and solid-state aspects of rare earths are covered. Separate abstracts were prepared for 28 papers. (M.C.G.)

For abstracts of individual papers see: 7588–7591, 8153–8155, 8208, 8298, 8319, 8320, 8365, 8539, and 8646–8660.

8646 (CONF-681020-(Vol.1), pp 17-28) RARE EARTH–COBALT PERMANENT MAGNETS. Strnat, Karl J. (Dayton Univ., Ohio).

Several intermetallic compounds of light rare earth metals, or yttrium, with cobalt are shown to be promising candidates for a technological application in fine-particle permanent magnets. Coercive forces and energy products considerably in excess of those for present-day commercial magnets were predicted. Experimentally, energy products up to 8.1×10^6 G · Oe and intrinsic coercivities to 28,700 Oe were achieved. These record values are for $SmCo_5$, which is now the subject of development work in several industrial laboratories as a likely replacement for the specialty magnet material PtCo. Technical problems exist with plastic deformation effects during particle preparation by grinding and with the chemical instability of the powders, but the main drawback is the present high cost of rare earths. However, mischmetal and other mixtures of rare earths can be employed. (auth)

8647 (CONF-681020-(Vol.1), pp 30-48) MAGNETO-CRYSTALLINE PROPERTIES OF RARE-EARTH SINGLE CRYSTALS. Feron, J. L.; Pauthenet, R. (Grenoble Univ. (France). Laboratoire d'Electrostatique et de Physique du Metal).

The magnetization of some rare earth single crystals was measured along the three principal crystallographic axis of the hexagonal close-packed structure in magnetic fields up to 80 kOe and in the temperature range between 1.8 and 300°K. Data are given for Gd, Ho, Tb, Dy, and Er. (M.C.G.)

8648 (CONF-681020-(Vol.1), pp 49-58) ON THE MAGNETIC CHARACTERISTICS OF Pr–La AND Pr–Y ALLOYS AND THE NATURE OF ELEMENTAL PRASEODYMIUM AT LOW TEMPERATURES. Wallace, W. E.; Kissell, F.; Segal, E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry).

Magnetic susceptibilities of Pr and Pr–Y alloys are reported for the temperature range 2 to 300°K and for field strengths (H) up to 21 kOe. The alloys show deviations from Curie–Weiss behavior and a tendency toward temperature-independent susceptibility similar to that exhibited by elemental Pr. χ at 4.2°K for Pr decreases sharply with alloying; its Weiss constant changes sign with as little as 10% La or Y. χ at 4.2°K decreases with increasing H above 10 kOe; the decrease is progressively eliminated by alloying with Y or La, and is not observed at 300°K. The operator equivalent method is used to calculate the energy level structure and associated magnetic moments for cubic and hexagonal Pr^{3+} ions. Influence of the sixth order term and H is included. Using standard formulas it is possible to account for the χ versus T behavior for $Pr_{0.5}La_{0.5}$; the overall splittings at the cubic and hexagonal sites are the same as those found by Bleaney for Pr. Extension of the analysis to Pr enables most of its unusual characteristics to be understood. Appearance of spontaneous magnetization is predicted at T_c, where T_c is calculated to be in the range 24.4 to 32°K, depending on the choice of the molecular field

coefficient. This compares favorably with 25°K observed by neutron diffraction techniques. From analysis it is also clear why the magnetic ordering in Pr is only a weakly cooperative process and order is confined to the hexagonal sites. The new concept of Pr represents a way of harmonizing the two seemingly contradictory models used earlier in describing its low temperature magnetic behavior. (auth)

8649 (CONF-681020–(Vol.1), pp 79-89) MAGNETIC PROPERTIES OF CERIUM METAL AND ALLOYS. Coqblin, B. (Paris Univ., Orsay (France). Faculte des Sciences).

Some theoretical investigations of cerium metal and its alloys are presented. The strong exchange-enhancement in α–cerium was studied, and the case of alloys with cerium impurities is discussed. For cerium alloys, the nonmagnetic alloys, with a possible local exchange-enhancement effect, are distinguished from the magnetic alloys showing a Kondo effect and other related properties, such as the anomalous pressure dependence of the superconducting temperature for La–Ce alloys. (auth)

8650 (CONF-681020–(Vol.1), pp 91-103) MAGNETIC PROPERTIES OF RARE EARTH–INDIUM COMPOUNDS. Buschow, K. H. J. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Forschungslaboratorium); de Wijn, H. W.; van Diepen, A. M. (Amsterdam Univ. (Netherlands). Natuurkundig Laboratorium).

The magnetic properties and the lattice parameters for thirteen compounds of the composition RIn_3 (Cu_3Au structure) are reported. The magnetic measurements were performed between 4.2 and 500°K with magnetic fields up to 30 kOe. With the exception of compounds with R = La, Sm, Y, and Yb Curie–Weiss behavior was observed in the high-temperature region. At low temperatures the magnetic behavior for compounds in which R = Ce, Nd, Sm, Gd, Tb, Dy, Ho, and Er is ascribed to antiferromagnetic ordering. In the case of $PrIn_3$ magnetic ordering is prevented by crystalline fields. The splitting of the J = 4 state for Pr^{3+} by cubic crystalline fields was calculated for various combinations of fourth- and sixth-order potentials. Possible energy diagrams are presented. (auth)

8651 (CONF-681020–(Vol.1), pp 105-15) MAGNETIC CHARACTERISTICS OF 2-17 LANTHANIDE–NICKEL COMPOUNDS. Carfagna, Paul D.; Wallace, W. E. (Pittsburgh Univ., Pa. Dept. of Chemistry).

Magnetic characteristics of 9 compounds represented by the formula Ln_2Ni_{17} (Ln = Y or a lanthanide) are reported. The Y, Sm, and Lu compounds are ferromagnetic; the others are ferrimagnetic. Curie temperatures range from 601 to 641°K. The nickel moment is 0.27 μ_B, which is in very close agreement with 0.25 μ_B, the value expected if all Ln valence electrons are transferred into the Ni 3d band. Magnetization of the Y_2Ni_{17} and Lu_2Ni_{17} compounds is lost in two stages as temperature is increased. Ferrimagnetism of heavy lanthanide compounds is indicated by the magnitude of their saturation moments and the form of the magnetization–temperature curves. The magnetic coupling is the same as that observed in similar and related Ln–Co and Ln–Fe compounds; i.e., the Ln–Ni coupling is antiferromagnetic and ferromagnetic for heavy and light lanthanides, respectively. From the Curie temperature it is inferred that the Ni–Ni interaction is dominant. This is in contrast with the situation in Ni-containing Laves and Haucke phases, in which the Ln–Ln interaction is dominant. (auth)

8652 (CONF-681020–(Vol.1), pp 117-22) MAGNETIC CHARACTERISTICS OF $TbAu_2$. Sill, L. R. (Northern Illinois Univ., De Kalb); Fedro, A. J. (Northern Illinois Univ., De Kalb. Argonne National Lab., Ill.); Kimball, C. W. (Argonne National Lab., Ill.).

The magnetic susceptibility and temperature dependence of the hyperfine interaction at ^{197}Au nuclei were measured for the intermetallic compound $TbAu_2$ (isostructural with $MnAu_2$). The magnetization measurements showed a temperature dependence that is characteristic of a paramagnetic–antiferromagnetic transition at 55°K and a discontinuity that is characteristic of a first-order transition at 43°K. Both of these observations are in agreement with the neutron diffraction results of Atoji. The magnetic hyperfine field at the Au nuclei indicates that the net polarization of the conduction electrons is very nearly zero. The isomer shift indicates a charge transfer to the Au atom. On the basis of the s–f exchange model and free electron theory, the number of conduction electrons per molecule necessary to account for the turn angle of π for the antiferromagnetic ground state is approximately 1.78. This value is very close to that value (1.67) expected on the basis of normal valence considerations. (auth)

8653 (CONF-681020–(Vol.1), pp 123-35) MAGNETIC PROPERTIES AND MAGNETIC STRUCTURES OF TmAl. Becle, C.; Feron, J. L.; Lemaire, R.; Pauthenet, R. (Grenoble Univ. (France). Laboratoire d'Electrostatique et de Physique du Metal).

TmAl was prepared by melting the elements in a high-frequency levitation furnace. The magnetization was measured by an axial extraction method at temperatures between 2 and 300°K in high magnetic fields up to 70 kOe. The calculations required for determination of the magnetic structure were made with a CAG 510 computer. (M.C.G.)

8654 (CONF-681020–(Vol.1), pp 137-44) EFFECT OF HIGH PRESSURES ON THE CURIE TEMPERATURES OF RARE-EARTH INTERMETALLIC COMPOUNDS. Alfieri, G. T.; Kanematsu, K.; Banks, E. (Polytechnic Inst. of Brooklyn, N. Y.).

The effect of high pressures on the strength of the magnetic exchange interactions in ferromagnetic rare earth compounds of zinc and cadmium, with CsCl structure, was investigated. The experiments were done in a "girdle" apparatus by a transformer method, as described by McWhan, et al. The Curie point was detected by a change in the secondary voltage. Results on the rare earth–zinc compounds are as follows: the Curie temperature of GdZn decreases with increasing pressure at a rate of −0.3°K/kbar. For TbZn, dTc/dp is approximately zero, while the Curie temperature of DyZn increases with increasing pressure, with dTc/dp approximating +0.7°K/kbar. These results appear to confirm the notion that the dependence of the exchange interaction in interatomic distance follows a "Heisenberg" type curve, with a maximum in the region of TbZn. This compound, and GdZn would be placed at the left side of the curve, while DyZn would be on the right side, where decreasing interatomic spacing leads to an increase in the strength of the ferromagnetic exchange interaction. (auth)

8655 (CONF-681020–(Vol.1), pp 261-72) CRYSTAL-FIELD INTERACTIONS IN RARE EARTH INTERMETALLIC COMPOUNDS. Jones, E. D. (Sandia Labs., Albuquerque, N. Mex.).

Temperature dependences of the phosphorus, arsenic, antimony, and bismuth nuclear magnetic resonance (NMR) Knight shifts in the NaCl-type rare earth group VA intermetallic compounds were previously studied. An analysis of the NMR data in these compounds showed that, in general, the temperature-dependent part of the Knight shift K(T) obeys a Curie–Weiss law. However, for the praseodymium and thulium compounds, an examination of the temperature dependence of the Knight shift data showed that the effect of the six-fold cubic crystalline field interaction cannot be neglected. Hence, by fitting the observed NMR data in these particular compounds to a theoretical expression for the paramagnetic susceptibility of $Pr^{3+}(^3H_4)$ and $Tm^{3+}(^3H_6)$ in a cubic crystal field, information concerning the strength of the cubic crystal field and exchange interactions can be derived. These results, together with the NMR derived values of the s–f exchange energies are presented and discussed for PrP, PrAs, TmP, TmAs, and TmSb. (auth)

8656 (CONF-681020–(Vol.1), pp 273-81) CRYSTAL CHEMISTRY OF SOME SCANDIUM AND LANTHANIDE COMPOUNDS. Dwight, A. E. (Argonne National Lab., Ill.).

Crystal structures are reported for 17 intermetallic compounds with either scandium or a lanthanide as one of the components. Representative compounds and their structure type are ScNiGa ($CeCu_2$ type), ScCuGe (Fe_2P type), Sc_2CuGa_3 ($InNi_2$ type), Ce_2Mn_3Al ($MgZn_2$ type), and HoAlGa (AlB_2 type). Unit-cell constants were determined from x-ray powder data by a computer program. The stability of competing structure types is discussed in terms of the relative atomic size, the electron concentration, and the equivalence of lattice sites. (auth)

8657 (CONF-681020–(Vol.1), pp 283-94) VALENCE BONDING IN THE RARE EARTH LAVES PHASES. Carter, Forrest L. (Naval Research Lab., Washington, D. C.).

Coordinations of 16 and 12 are important among transitional metal compounds and are the only coordinations in the AB_2 Laves phases. Mutually orthogonal bidirectional orbitals are used in an elementary valence bond discussion of these coordinations. The point symmetry of 32 is employed in the development of the orbitals for both the Friauf polyhedral (16) coordination and the icosahedral (12) coordination. In the first case, the A atom is surrounded by twelve B atoms and four A atoms. The twelve B atoms can be bonded to two different sets of six G-type orbitals of the form $G = as + bp_x + id_{x^2}$ rotated by the angle α about the x axis. The four A atoms can be bonded to the central A atom in three different ways by two C-type orbitals of the general form $C = ap_x + \sqrt{1-a^2}d_{xz}$. The use of these orbitals permits a discussion of the unusual "compressibility" of the A–A bonds associated with the hard sphere model as well as the wide existence range of the Laves phases. Differences in the hybridization between the A–A and the A–B bond is seen as the reason for the failure of the hard sphere model. The icosahedral coordination

of the B atom leads to the use of C-type bonding orbitals related by 32 point symmetry. Predictions arising from the treatment involve the change of the atomic parameters in the C14 phase as a function of rare earth atomic number, a new rare earth cubic phase of the composition $A_{0.5}A^{s}_{0.5}B_2$, and band features of the Laves phases. (auth)

8658 (CONF-681020–(Vol.1), pp 335-46) SUSCEPTIBILITY OF Pr^{3+} ION SITUATION IN A HEXAGONAL CRYSTAL FIELD. Segal, E. (Pittsburgh Univ., Pa. Dept. of Chemistry).

A Hamiltonian containing second-, fourth-, and sixth-degree terms was constructed for an ion situated in a hexagonal crystal field under the influence of an external magnetic field directed along the c-axis. The Hamiltonian was solved for the case J = 4 and the energy levels, eigenfunctions and the magnetic moments of all levels were obtained. These data were used successfully to explain the magnetic behavior of $PrAl_2$ as a function of temperature. (auth)

8659 (CONF-681020–(Vol.1), pp 347-58) MAGNETIC FIELD DEPENDENCE OF Eu NUCLEAR RESONANCE IN FERROMAGNETIC EuS. Christensen, C. R.; Daniel, A. C.; Guenther, B. D. (Army Missile Command, Redstone Arsenal, Ala.); Teaney, D. T. (IBM Watson Research Center, Yorktown Heights, N. Y.).

The magnetic field dependences of $^{151,153}Eu$ nuclear magnetic resonances in a sintered, polycrystalline sphere of EuS were investigated by means of a transmission-line spectrometer from 1.2 to 4.2°K. The resonance frequencies were found to exhibit a near zero field dependence up to about 4 kOe, or up to the onset of magnetic saturation, and above about 6 kOe the resonance frequencies decreased in a linear manner with temperature-dependent slopes. This effect is explained by considering the signals to originate from both wall and domain nuclear sites in the low field region where the external field is cancelled by the demagnetizing field. At the higher fields the sample is saturated and the external field subtracts from the large internal field giving the linear shift in frequency. (auth)

8660 (CONF-681020–(Vol.1), pp 359-70) ANOMALOUS HALL EFFECT IN RARE EARTH METALS. Rhyne, James J. (Naval Ordnance Lab., White Oak, Md.); Lee, Ronald S. (Kansas State Univ., Manhattan).

The anomalous or magnetization-dependent contribution to the Hall effect was investigated in rare earth single crystals. Principal emphasis is placed on Dy and a comparison of the basal plane anomalous coefficient in the magnetically ordered phase with results on Gd. The anomalous coefficent R_s in Dy exhibits a reversal in sign from negative to positive below the ordering temperature. Possible mechanisms are discussed for the occurrence of this sign change which is not observed in the S-state ion Gd. A peak in R_s of $+21 \times 10^{-12}$ ohm-cm/G for H applied along $\langle 11\bar{2}0 \rangle$ in Dy occurs near 120°K with a gradual decrease to zero below 30°K. A strong temperature dependence is observed in the Hall resistivity above the Néel temperature, which results entirely from the magnetic susceptibility, leaving $R_s = -18 \times 10^{-12}$ ohm-cm/G and temperature independent above 190°K. This fact plus a linear dependence of the low temperature R_s data on the magnetic component of the total resistivity indicate that the dominant scattering mechanism in the Hall effect is the thermal disorder of the 4f spin system. (auth)

8661 (CONF-681020–(Vol.2)) PROCEEDINGS OF THE SEVENTH RARE EARTH RESEARCH CONFERENCE, CORONADO, CALIFORNIA, OCTOBER 28-30, 1968. VOL. II. SESSIONS I THROUGH M. (International Harvester Co., San Diego, Calif. Solar Div. National Science Foundation, Washington, D. C.). 421p. (In French and English). CFSTI.

Thirty six papers and four abstracts of papers on the chemistry, solid-state processes, geochemistry, industrial processes, and metallurgy of rare earths are presented. Separate abstracts were prepared for 16 papers. (M.C.G.)

For abstracts of individual papers see: 7442, 7499, 7549, 7592, 7593, 8128, 8209–8211, 8268, 8269, 8299, 8300, and 8662–8664.

8662 (CONF-681020–(Vol.2), pp 783-9) DENSITY OF STATES OF SOME RARE EARTH OXIDES FROM AN X-RAY ISOCHROMAT INVESTIGATION. Bergwall, S.; Nigavekar, A. S. (Uppsala Univ. (Sweden). Inst. of Physics).

Some results of a systematic investigation of the intensity distribution near the high-frequency limit of the continuous x-ray spectrum for the rare earth oxides from Sm to Lu are reported. The intensity distribution was measured as a function of the voltage applied across the x-ray tube. A high-resolution spectrometer with a bent crystal monochromator adjusted for the 2285.00 X.U. wavelength of the Cr $K\alpha_1$ was used. The information obtained indicates that the distribution of valence electrons in the different outer states varies very smoothly but must in the absence of 5d electrons be affected by the 4f electrons in some oxides. Applying a rigid band model it seems reasonable to assume the density of unfilled states at the Fermi level to be governed by the 5d as well as by the 4f bands. (auth)

8663 (CONF-681020–(Vol.2), pp 833) ELECTRONIC PROPERTIES OF THE COMPOUNDS $NdAl_2$, $TbAl_2$, $GdAl_2$, $LaAl_2$, AND $YbAl_2$. van Daal, H. J.; Buschow, K. H. J. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Forschungslaboratorium).

The electrical resistivity (ρ) of a number of RAl_2 compounds, where R denotes a rare earth element, was measured at temperatures between 4.2 and 293°K. In the same temperature range, data were also obtained for magnetoresistance (ρ_m) and for the Hall coefficient (R_H) for magnetic fields up to 23 kOe. The material investigated was either ferromagnetic (R: Nd, Tb, or Gd) or nonmagnetic (R: La), while $YbAl_2$ showed a magnetic behavior that is not yet understood. In the preparation of the material special care was taken for obtaining homogeneous, single-phase samples. An explanation is given of the ρ-behavior as found, in terms of the existing theories for electrical conduction in these types of materials. The data for ρ, ρ_m, and R_H are compared with those obtained for the magnetic susceptibility and the saturation magnetization. Finally Knight-shift data as given in literature are implicated in the discussion of the results. (auth)

8664 (CONF-681020–(Vol.2), pp 847-60) RESISTANCE MINIMA IN SOME NONDILUTE RARE-EARTH ALLOYS. Hill, H. H.; Elliott, R. O.; Miner, W. N. (Los Alamos Scientific Lab., N. Mex.).

Minima were observed in the low-temperature electrical resistivity data of certain nondilute Ce–La and Ce–Y solid solution alloys. The minima are probably indicative of a spin-compensated magentic state. In the Ce–La alloys, for La concentrations of ≥21 at. % resistively determined ordering temperatures coincided with those of one of two previously observed specific heat anomalies but not with previously established Néel temperatures. In the Ce–Y system, Néel temperatures were determined resistively for Y concentrations up to 60 at. %. A resistance minimum was observed for a La–10 at. % Pu alloy. (auth)

8665 (COO–294-8) PARAMAGNETIC RESONANCE ABSORPTION. Progress Report. Hutchison, Clyde A. Jr. (Chicago Univ., Ill. Dept. of Chemistry). Dec. 1968. Contract AT(11-1)-294. 9p. Dep. CFSTI.

New and modified apparatus for studies on paramagnetic resonance absorption are described. The fitting of spin hamiltonians to the ENDOR spectra of $^{147}Sm^{3+}$ and $^{149}Sm^{3+}$ in $LaCl_3$ single crystals was completed. Single crystals of ThO_2 were doped with ^{235}U and the $^{235}U^{4+}$ nuclear hyperfine patterns arising from the f electrons of the Γ_8 state of U^{4+} at the Th^{4+} site were obtained. Studies of electron spin double resonance and of the dynamics of ENDOR in rare earth ions in single crystals were begun. The ENDOR spectra of triplet-state protobenzene in deuterobenzene single crystals is being investigated along with diphenylmethylene in diphenylethylene crystals and phenanthrene in diphenyl. Zero field line shapes are discussed. (M.C.G.)

8666 (JINR–P4-4146) POLARIZATION TRANSFER BY MEANS OF MAGNETIC INTERACTION OF NUCLEI IN MONOCRYSTAL. Vdovin, A. I.; Podgoretskii, M. I.; Smirnov, S. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 15p. (In Russian). Dep.

The behavior of the spin system in the external electric and magnetic fields near the crossing points of the energy levels is considered. In particular, the peculiarities of this behavior at fast and slow change of the magnetic field, in connection with the spin reorientation, are analyzed. The case for two spins is considered in detail and generalization is made for the case of any number of interacting spins. (auth)

8667 (UCRL–71082(Rev.1)) THE EFFECTS OF HEAT TREATMENTS OF GERMANIUM ON RESISTIVITY, PHOTOCONDUCTIVE DECAY, AND ON LITHIUM DRIFT PROPERTIES. Fischer-Colbrie, Erwin; Brown, T. G.; Friensehner, A. V. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1968. Contract W-7405-eng-48. 13p. (CONF-681017–10). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

The effects of heat treatments on resistivity, photoconductive decay and lithium-drift properties of p-type germanium single crystals have been investigated. It was found that, in contrast to literature thermally produced acceptors cannot be reconverted if vacuum is used instead of a gas during anneal treatments. Vacuum heat treatments also lead to a stronger decrease of the photoconductive decay time than a gas atmosphere does. Close to theoretical lithium drift rates considerably decrease in heat treatments, poor drift rates can be improved. The effects of quenching

differ distinctly from those of slow cooling. The surface exposed to vacuum can be assumed to be a more abundant source of single vacancies due to a lower density of sorption engagements. Single vacancies diffuse then rapidly into the bulk and become less mobile in interactions, possibly with (interstitial) copper, thus providing stable p-sites. (auth)

8668 EFFECT OF PLASTIC DEFORMATION ON THE THERMAL BLEACHING OF THE F BAND IN THE CRYSTALS OF LiF IRRADIATED WITH γ RAYS. Serughetti, Jean (Faculte des Sciences, Strasbourg). Compt. Rend., Ser. A and B, 267: 719-22 (Oct. 7, 1968). (In French).

The plastic deformation of LiF crystals irradiated with γ rays provokes, during annealing, a decrease of the bleaching rate of the F band proportional to the deformation degree. The kinetics of the phenomenon is compatible with a second-order reaction where the activation energy is the same for deformed and nondeformed crystals. (tr-auth)

8669 STRESS-INDUCED ORDERING OF POINT DEFECTS IN COPPER NEAR 10°K. Neilsen, R.; Townsend, J. R. (Univ. of Pittsburgh). Phys. Rev. Lett., 21: 1749-51(Dec. 23, 1968).

An anelastic process near 10°K has been found in proton-irradiated copper. It is tentatively identified as the result of stress-induced ordering of the interstitial member of a close pair. The reorientation occurs without annealing being observed. The thermal activation energy for reorientation is 0.015 eV; the strain symmetry axis is in the ⟨111⟩ direction. (auth)

8670 STUDY OF DYNAMIC EFFECTS IN PARAMAGNETIC RESONANCE OF Gd IN $LaNi_5$ INTERMETALLIC COMPOUNDS. Davidov, D.; Shaltiel, D. (Hebrew Univ., Jerusalem). Phys. Rev. Lett., 21: 1752-5(Dec. 23, 1968).

The EPR studies of Gd in $LaNi_5$ reveal appreciable dependence of the g shift on temperature, concentration, and magnetic field. This dependence is attributed to the existence of dynamic effects. The agreement between theory and the experimental results is satisfactory. (auth)

8671 BRAGG SCATTERING OF MOESSBAUER GAMMA RADIATION BY AN IDEAL CRYSTAL. Sklyarevskii, V. V.; Smirnov, G. V.; Artem'ev, A. N.; Sestak, B.; Kadeckova, S. JETP Lett. (USSR) (Engl. Transl.), 8: 181-4(Sept. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 8: 295-300(Sept. 20, 1968).

The Bragg scattering of 14-keV Moessbauer radiation of ^{57}Fe nuclei was investigated by an ideal crystal Fe + 3% Si of natural iron. It was demonstrated experimentally that the scattering of Moessbauer gamma radiation by an ideal crystal differs greatly from scattering by a mosaic crystal, in agreement with the predictions of the theory. (M.H.R.)

8672 EFFECT OF BOMBARDMENT TEMPERATURE ON THE TRAPPING OF XENON IN SOME OXIDES AND HALIDES. Matzke, Hj.; MacEwan, J. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 28: 316-23(1968).

The effect of ion bombardment temperature on the subsequent release of xenon during postirradiation annealing was investigated. For materials resistant to irradiation damage, increasing the bombardment temperature had little effect if the temperature was still low enough to avoid appreciable diffusion of the free gas atoms ($T \leq 0.4\ T_{melting}$). An effect was observed with bombardment doses high enough to cause trapping of xenon, if the bombardment temperature was above that required for migration of the free gas but below that required for escape of the temporarily trapped gas. The retained gas in such samples will be primarily trapped gas, while a similar sample bombarded to the same dose at room temperature will contain both free and trapped xenon. A third effect was noted with MgO, which is subject to gross structural damage during irradiation. Samples bombarded at room temperature to an appreciable dose exhibited a large release of gas at low temperature coincident with the annealing of the damage, while samples bombarded to the same dose above the annealing temperature for damage exhibited normal diffusional release. (auth)

8673 CONTRIBUTION TO THE INVESTIGATION OF THE SEMICONDUCTORS OF EUROPIUM SESQUIOXIDES. Schwab, Georg-Maria; Bohla, Friedrich (Univ., Munich). Z. Naturforsch., 23a: 1549-54(Oct. 1968). (In German).

With an apparatus already tested with high-resistant oxide materials, a measurement of the electrical conductivity of polycrystalline sintered material of cubic or monoclinic europium sesquioxide was made by direct current–voltage measurement under air or a controlled atmosphere of various pressures. At high, as well as at extremely low, oxygen partial pressure the temperature dependence of the conductivity was observed on doped and undoped oxide samples at constantly maintained pressure; the oxygen pressure dependence of the conductivity was also noted at constant temperature. An attempt was made to give a hole model for the perturbation mechanism occurring. (tr-auth)

8674 ESR STUDIES OF ELECTRON IRRADIATION DAMAGE AND ITS ANNEALING IN As-DOPED n-TYPE GERMANIUM. Hashiguchi, Ryukiti R.; Tanaka, Kazuhide (Nagoya Inst. of Tech., Japan). Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 11: 1-5(July 1968). (In Japanese).

A new EPR spectrum was observed for n-type germanium with As, due to the lattice defects caused by the 6-MeV electron irradiation at about 40°C. From the detailed study on the G value and annealing characteristics of the spectrum, it was found that the C spectrum, as named, could be considered as due to the compound (AsV_2). The annealing behavior was examined in relation with that of the compound (AsV_2). (NSA of Japan)

8675 HALL EFFECTS IN RARE-EARTH METALS. Abel'-skii, Sh. Sh.; Irkhin, Yu. P. (Urals Wood Tech. Inst., Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 1768-9(Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2245-7(July 1968).

Calculations are made for the ordinary Hall coefficients R_0, assuming a gap in the current carrier spectrum proportional to relative magnetization. The case where a carrier spectrum gap exists in other directions as well as the Z-direction, and a Fermi surface everywhere lies close to this gap, is considered along with the case of a spiral vector directed along the hexagonal axis of the crystal. Graphs of the R_0 versus T in the neighborhood of T_N (antiferromagnetic transition temperature) are presented. Possible ways of explaining the resistance and Hall-effect anomalies close to the transition temperatures are considered. (D.L.C.)

8676 OPTICAL ABSORPTION IN LaSb. Goncharova, E. V.; Zhuze, V. P.; Lukirskii, D. P. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 1784-5(Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2262-3(July 1968).

The absorption coefficient of amorphous and polycrystalline vapor-deposited LaSb layers was measured at wavelengths from 0.25 to 2.5 μ. A minimum in the absorption is present at ~1.5 μ, and a value of $>10^5\ cm^{-1}$ is attained at 0.6 to 0.25 μ. This high absorption is due to interband transitions and follows the equation: $\alpha \simeq (h\omega - 0.8\ eV)^{0.5}$. The absorption on the other side of the minimum also increases with a $1/\omega^2$ dependence. (D.L.C.)

8677 ADSORPTION OF CARBON MONOXIDE ON (110) AND (113) SURFACES OF TUNGSTEN SINGLE CRYSTALS PARTLY COVERED BY OXYGEN. Ageikin, V. S.; Ptushinskii, Yu. G. (Inst. of Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.), 10: 1698-1704(Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2168-76(July 1968).

The effect of oxygen absorption on (110) and (113) faces of tungsten single crystals on the parameters of subsequent CO absorption is investigated. The presence of oxygen on the surface leads to a decrease of the limiting surface concentration CO, and of its condensation coefficient and its heat of adsorption. The relative effect of oxygen is particularly pronounced at low surface concentrations. It is assumed that a fundamental role is played by the electrostatic interaction between the oxygen atoms carrying excess electric charge and the CO molecules having a dipole moment. The dependences of the condensation coefficient κ(n) and the heat of adsorption q of CO on its surface concentration n are obtained; the maximum values κ for clean (110) and (113) surfaces are ~0.14 and ~0.35, respectively; the corresponding values are q ~3.5 eV and q ~3.8 eV. The dependences q(n) for the two surfaces indicate the presence of three phases of CO adsorption. This multiphase character is conserved also after fractional coverage of the surface by oxygen. Measurements are carried out to determine the dependence of the change in the work functions on the CO surface concentration. The initial slope of these curves, which at low concentrations is proportional to the effective dipole moment of the adsorbed CO molecule, is considerably diminished with rising substrate temperature; this is explained by thermal disorientation of the dipoles. (auth)

8678 THE MAGNETIC PROPERTIES OF $EuLu_2O_4$ AT LOW TEMPERATURES. Samokhvalov, A. A.; Morozov, Yu. N.; Bamburov, V. G.; Volkenshtein, N. V.; Zotov, T. D. (Inst. for Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 1729-30(Jan. 1969).

Translated from Fiz. Tverd. Tela, 10: 2206-8(July 1968).

The unit cell parameters of $EuLu_2O_4$ and Eu_3O_4 are compared. The magnetization of $EuLu_2O_4$ was measured at 1.7 to 300°K, and the spontaneous and saturation magnetizations were obtained by extrapolation. The principal magnetic parameters (Curie temperature, saturation magnetization, and magnetic moment per Eu^{2+} ion) are compared for $EuLu_2O_4$ and Eu_3O_4. Their magnetic

structures are discussed; if $EuLu_2O_4$ is also metamagnetic, its threshold field is considerably less than 1.1 kOe. The spontaneous magnetization of $EuLu_2O_4$ follows the antiferromagnetic T^2 law, like Eu_3O_4. (D.L.C.)

8679 INVESTIGATION OF DEFORMATION LUMINESCENCE. Shmurak, S. Z. (Solid State Physics Inst., Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 1526-30(Jan. 1969). Translated from Fiz. Tverd. Tela, 10: 1934-40(July 1968).

The stress dependence of the number of radiated quanta of recombination radiation was investigated in x-irradiated crystals of KCl and KCl : Cu. It was shown that the number of radiated light quanta is proportional to a dislocation deformation. The nature of the stress dependence of the dislocation deformation is well described by the theory of Granato and Lücke. Under the assumption that upon load removal, parts of the dislocations coalesce elastically, the dependence of the damping decrement upon load was found. The idea of the dislocation damping decrement is introduced. Quantities characterizing the concentration of impurities on dislocations are determined from the stress dependence of the number of light quanta emitted during deformation. The influence of copper impurities on the dynamics of dislocation motion in a KCl crystal is discussed. (auth)

8680 RECOMBINATION LUMINESCENCE FROM SELF-TRAPPED EXCITONS IN AMMONIUM HALIDE CRYSTALS. Marrone, M. J.; Kabler, M. N. (Naval Research Lab., Washington, D. C.). Phys. Rev., 176: 1070-5(Dec. 15, 1968).

Luminescence due to intrinsic self-trapped exciton annihilation has been observed in ammonium halide single crystals under x irradiation at low temperatures. A broad emission band appears at 4.86 eV for NH_4Cl, 4.20 eV for NH_4Br, and 3.74 eV for NH_4I. The source of the luminescence is identified primarily through an experiment which relates the polarization of the luminescence to the orientation of self-trapped holes or V_k centers. As in the alkali halides, the self-trapped exciton may be characterized as a bound pair of nearest-neighbor halide ions in an excited state. The transition in NH_4Cl is σ-polarized with respect to the pair axis, and its lifetime under pulsed x-ray excitation is on the order of 10^{-8} sec. The NH_4Br emission band consists of two overlapping transitions. There is a fast σ-polarized component similar to that found in the chloride. The other component is π-polarized and has a longer lifetime of 7.7×10^{-7} sec. Comparison is made between these transitions and similar transitions previously observed in the alkali halides. It is concluded that the self-trapped exciton states are essentially the same in the two materials; in particular, a triplet state evidently initiates the long-lived emission band. (auth)

8681 ESR STUDIES OF RADIATION-DAMAGE CENTERS IN BARIUM SULFIDE. Kolopus, James L. (Oak Ridge National Lab., Tenn.); Lapeyre, Gerald J. Phys. Rev., 176: 1025-9 (Dec. 15, 1968).

Single crystals of BaS have been grown and irradiated with neutrons, producing an intense F-center spectrum with a spectroscopic splitting factor, $g = 1.9637 \pm 0.0005$. The isotropic part of the hyperfine interaction A is 41.0 ± 0.2 and 36.4 ± 0.2 G for the nearest-neighbor ^{137}Ba and ^{135}Ba nuclei, respectively. The dipolar hyperfine interaction constants B are found to be 4.0 ± 0.1 and 3.8 ± 0.1 G, respectively, for the same nuclei. F centers were also observed in samples which had been crushed or γ-irradiated following deformation. Other damage centers were observed with less intensity than the F center and are briefly discussed. (auth)

8682 THERMAL AND ELECTRICAL CONDUCTIVITIES OF VERY-HIGH-PURITY INDIUM. de la Cruz, M. E.; de la Cruz, F.; Cotignola, J. M.; Bressan, O. J.; Luengo, C. A. (Comision Nacional de Energia Atomica San Carlos de Bariloche, Rio Negro, Argentina). Phys. Rev., 176: 871-5(Dec. 15, 1968).

Measurements of the thermal and electrical conductivities of a polycrystalline indium sample of very high purity have been performed between 1.5 and 4.2°K and in the presence of longitudinal magnetic fields up to 15,000 Oe. It was found that, within the experimental error, the electrical and thermal Kohler's rules were satisfied, the functional forms for the two being quite similar. The expression for the resistivity as a function of T for the normal state and in zero magnetic field are in good agreement with theory. The Lorenz number obtained by extrapolating to $T = 0$ gives a very high value compared with the theoretical one. Measurements of the thermal conductivity for the superconducting state, in the same temperature range, have been made. The thermal-resistivity ratio W_s/W_n as a function of the reduced temperature does not agree with the results of Kadanoff and Martin. (auth)

8683 HIGH-TEMPERATURE RECOVERY OF TUNGSTEN AFTER NEUTRON IRRADIATION. Keys, L. K.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Phys. Rev., 176: 851-6(Dec. 15, 1968).

The recovery of neutron-irradiation-induced defects in tungsten has been investigated via isochronal resistivity studies after irradiations from 8.5×10^{17} to 1.5×10^{21} n cm^{-2} ($E_n > 1$ MeV). These studies have shown that after irradiation at reactor ambient temperature (~70°C), recovery occurs in three principal recovery regions. The first region (stage III) occurs between 100 and 450°C, the second between 450 and 650°C, and the third (stage IV) between 650 and 1000°C. The temperature of maximum recovery of the stage-III region decreased from 360 to 270°C with increasing fluence. The temperature of the maximum recovery of the second region also appears to decrease slightly with increasing fluence. The temperature of maximum recovery of stage IV is independent of the neutron fluence over the fluence range utilized in this investigation. A residual resistivity, remaining after completion of the isochronal anneals, shows a linear (slope of 1) dependence on the thermal-neutron fluence. This is believed due to the formation of rhenium, as a result of thermal-neutron (n,γ) reactions in tungsten. The shifts of the peak temperatures of the lower-temperature recovery regions are believed to result primarily from the weakening of the lattice by rhenium at low temperatures and high thermal-neutron fluences. The shift of the stage-III recovery region may also contain effects due to interactions between overlapping damage regions. Above about 10^{20} n cm^{-2} ($E_n > 1$ MeV), a deviation from a linear dependence of the log of the resistivity on the log of the fast neutron fluence supports the approach of saturation. (auth)

8684 POSITRON ANNIHILATION IN YTTRIUM AND ZIRCONIUM. Gupta, R. P. (Ames Lab., Iowa); Loucks, T. L. Phys. Rev., 176: 848-50(Dec. 15, 1968).

The angular dependence of the positron annihilation radiation along the [0001] direction has been studied in yttrium and zirconium by the augmented-plane-wave method. The calculation was performed using a mesh of 250 points distributed uniformly throughout the 1/24 zone. A set of 32 reciprocal lattice vectors was used to determine the eigenvalues and eigenfunctions. Exchange was treated in the Slater's $p^{\frac{1}{3}}$ approximation. The calculated curve for yttrium shows a fairly good agreement with the experimental results of Williams and Mackintosh. The theory predicts a more pronounced hump in the curve near the zone boundary than is observed experimentally. The experimental data for zirconium are not available, but the calculation shows that the hump almost disappears as the d shell starts filling in. (auth)

8685 STAGE-III ANNEALING IN GOLD AFTER ELECTRON IRRADIATION. Lee, C.; Koehler, J. S. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., 176: 813-26 (Dec. 15, 1968).

Gold specimens of nominal 99.9999% purity were irradiated with 3-MeV electrons near liquid-nitrogen temperature. The damage production rate is found to depend on the purity of the specimen giving a lower value for the high-purity specimens. It is also found that the production rate is reduced remarkably by quenching the specimen before irradiation. For high-purity gold, a single large annealing peak is observed in stage III. The slope-change method and Primak analysis are employed to obtain the activation energy of stage-III annealing. Both methods give 0.85 ± 0.02 eV for the activation energy in high-purity irradiated specimens. The activation energies for quenched and for quench-plus-irradiated specimens of comparable purity are found to be 0.85 ± 0.03 and 0.86 ± 0.02 eV, respectively, agreeing with the value for the irradiated specimens within the experimental error. Somewhat lower values are obtained for specimens of lower purity. Second-order kinetics are obeyed in the main part of the stage-III annealing for the irradiated, quench-plus-irradiated, and quenched specimens. Various models are discussed to explain stage-III annealing. It is concluded that vacancy migration in stage III with interstitial clusters acting as sinks can account for the observed results most satisfactorily in the case of gold. (auth)

8686 LOW-FIELD ESR SPECTRUM OF TRIVALENT GADOLINIUM IN SINGLE-CRYSTAL THORIUM OXIDE. Marshall, S. A.; Johnson, G. A. (Argonne National Lab., Ill.). Phys. Lett., 28A: 258-9(Dec. 2, 1968).

The low-field ESR spectrum of Gd^{3+} in single-crystal ThO_2 was reinvestigated at 3-cm wavelength. Zeeman field strengths for all permitted transitions are found to be in substantial agreement with predictions as are relative intensity ratios. (auth)

8687 MAGNETIC INTERACTIONS IN HEAVY ATOMS. Goldschmidt, Z. B.; Pasternak, A.; Goldschmidt, Z. H. (Hebrew Univ., Jerusalem). Phys. Lett., 28A: 265-6(Dec. 2, 1968).

The inclusion of magnetic interactions in energy-level calcula-

tions of heavy atoms greatly improved the fit between observed and calculated multiplet splittings. Reliable and consistent values of the appropriate parameters were determined which agree remarkably well with available theoretical predictions. (auth)

8688 OBSERVATION OF MAGNETIC EFFECTS BETWEEN RARE EARTHS IN $GdCl_3$. Randazzo, D. J. (Johns Hopkins Univ., Baltimore). Phys. Lett., 28A: 269-70(Dec. 2, 1968).

Kramers degenerate states of Er^{3+} in $GdCl_3$ exhibit spontaneous Zeeman splittings below the Curie temperature without an external field. The effective fields acting on the states indicate that magnetic dipole–dipole effects alone cannot explain the splittings. (auth)

8689 MAGNETIZATION AND NUCLEAR MAGNETIC RESONANCE STUDY OF SCANDIUM–GADOLINIUM ALLOYS. Fradin, F. Y.; Ross, J. W.; Isaacs, L. L.; Lam, D. J. (Argonne National Lab., Ill.). Phys. Lett., 28A: 276-7(Dec. 2, 1968).

Nuclear magnetic resonance and magnetic susceptibility measurements are presented for a series of scandium–gadolinium alloys. An enhanced polarization of the conduction electrons is found to be of an oscillatory form beyond the near neighbors to the impurity. (auth)

8690 PARAMAGNETIC RESONANCE OF Eu^{2+} DISSOLVED IN Yb METAL. Schaefer, W.; Schmidt, H. K.; Huefner, S. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 28A: 279-80(Dec. 2, 1968).

The paramagnetic resonance of Eu^{2+} dissolved in Yb metal was measured between 1.6 and 77°K. The g-value is 1.970 ± 0.005, yielding a g-shift of $\Delta g = 0.023 \pm 0.005$. From this an exchange integral $J_{s\text{-}f} = -0.02$ eV is calculated. (auth)

8691 FIRST-PRINCIPLE PSEUDO-POTENTIAL CALCULATION OF THE ELASTIC SHEAR CONSTANTS OF BERYLLIUM. King, W. F.; Cutler, P. H. (Pennsylvania State Univ., University Park). Phys. Lett., 28A: 289-90(Dec. 2, 1968).

The three independent elastic shear constants of beryllium were calculated from a first-principle pseudopotential method. (auth)

8692 TEMPERATURE DEPENDENCE OF THE HALL EFFECT AND PARAMAGNETIC SUSCEPTIBILITY OF ZIRCONIUM AND RHENIUM. Volkov, D. I.; Kozlova, T. M.; Prudnikov, V. N.; Kozis, E. V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 2103-7(Dec. 1968). (In Russian).

The temperature dependence of the Hall field, paramagnetic susceptibility and electric resistance of polycrystalline Zr and Re is investigated in the 77 to 350°K temperature range. It is demonstrated that an anomalous Hall field exists in the investigated nonferromagnetic transition metals which varies with the temperature as T^2. The relations between the Hall coefficient and Pauli susceptibility χ ($R^* \sim \chi$) and the electric resistance ρ ($R^* \sim \rho^2$) are found. It is concluded that the Zr and Re d-electrons are to a great degree subject to the collectivization effect. (auth)

8693 SECOND-ORDER EFFECTS IN THE ELECTRON–NUCLEAR DOUBLE RESONANCE SPECTRUM. Zevin, V. Ya.; Ishchenko, S. S.; Ruban, M. A. (Inst. of Semiconductors, Kiev). Zh. Eksp. Teor. Fiz., 55: 2108-21(Dec. 1968). (In Russian).

A general expression for the effective nuclear spin hamiltonian is obtained for a paramagnetic center with hyperfine interaction with several nuclei. A theory of second-order effects in double electron-nuclear resonance (ENDOR) spectra is developed for sufficiently general cases. The theory is compared with an experiment performed on F centers in LiF, KCl, and KBr and completely explains the complex structure of the ENDOR lines. Comparison of the theory and experiment shows that the quadrupole interaction constant Q′ of the ^{39}K nucleus of sphere 1 of the F-center in KBr is positive and the respective constant of the ^{7}Li nucleus of sphere 1 in LiF is, within the accuracy of the experiments, zero ($Q' < 10$ kc/s). (auth)

8694 LUMINESCENCE IN MgO. Sibley, W. A.; Nelson, C. M.; Chen, Y. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 4582-9(May 15, 1968).

The phosphorescence and x-ray stimulated luminescence of a series of nominally pure MgO crystals were investigated. It is suggested that the series of emission peaks around 1.4 eV is due to $Mg(OH)_2$ impurity, and evidence is presented that substantiates the assignment of the 1.7- and 2.5-eV luminescence with Cr^{3+} and Ni^{2+}, respectively. The effect of electron and neutron irradiation on the samples is also discussed. (auth)

8695 SATURATION AND RECOVERY IN NEUTRON-IRRADIATED MOLYBDENUM. Keys, L. K.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Phys. Rev. Lett., 22: 57-60(Jan. 13, 1969).

A high-temperature (~70–1200°C) resistivity recovery study of fast-neutron-irradiated ($E_n \geq 1$ MeV) molybdenum shows an anomalous saturation effect above about (5 to 10) × 10^{19} n/cm^2. This effect is interpreted as resulting from the self-annealing of the stage-III defects at the higher fluences (~10^{21} n/cm^2) leaving essentially only the stage-IV defects after reactor ambient irradiation. (auth)

Theoretical Physics

Refer also to abstract 8543.

8696 (CEA-R–3569) STUDY OF A ONE-DIMENSIONAL MODEL FOR A SYSTEM OF INTERACTING FERMIONS. Gaudin, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1968. 199p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Orsay.

A one-dimensional model is described for a quantum system of fermions with attractive or repulsive interaction. The eigenvalues and eigenfunctions of the Hamiltonian with periodic boundary conditions are exactly determined. The knowledge of the spectrum is essentially applied on the study of the attractive gas, characterized by the presence of "pairs" or two-particle bound states. This system can be described as a gas of "one-dimensional deuterons," which has some analogy with a boson gas. Some extensive properties of the ground state are discussed, for example, energy as a function of the density and magnetization, for all the values of the coupling constant. The analytic properties of the energy function are studied, but not completely resolved. Finally, the elementary excitations of the phonon type are considered and the dispersion curves are given. (auth)

8697 (ITF–68–65) CALCULATION OF FREE ENERGY FOR THE MODEL SYSTEM WITH FOUR-FERMION PAIR INTERACTION FOR SYSTEMS WITH REPULSION. Bogolyubov, N. N. Jr. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 11p. Dep.

It is well known that there are rather few problems in statistical physics for which an asymptotically exact solution can be constructed. The model problems of superconductivity theory, as was shown by N. N. Bogolyubov, are among them. Bogolyubov has studied the problem of evaluating, at zero temperature, the ground-state energy and correlation functions asymptotically exact as $V \to \infty$. An essentially new step has been made by developing an asymptotic method of calculation of free energy for BCS-type systems, a method suitable for any temperatures. However, the problem of constructing an asymptotically exact solution for the model with four-fermion pair interaction corresponding to electron repulsion near the Fermi surface has been open so far. It should be noted that the methods developed earlier cannot be immediately applied in this case since they are based on introducing the so-called approximation Hamiltonian containing a parameter C. The latter is determined by the condition of minimum of the free energy calculated for the approximation Hamiltonian. However, the minimum of such a function of C can exist only for the negative four-fermion interaction. If the BCS-type interaction is positive, the free energy, considered as a function of the parameter C possesses no absolute minimum. A different approach to the problem is discussed. (auth)

8698 EXTENSION OF WEINBERG'S QUASI-PARTICLE THEORY TO STANDING WAVES. Huby, R. (Univ. of Liverpool). Z. Phys., 218: 417-30(1969).

In the context of a potential, a résumé of scattering theory is developed along two alternative lines, either (a) by the resolvent of the Lippmann–Schwinger equation, leading to the reaction matrix T, or (b) by a modified resolvent associated with standing waves, leading to the reactance matrix K. On this basis, it is shown that Weinberg's theory of quasi particles, which was originally appropriate to the scheme (a), has a counterpart in the scheme (b), in which the quasi-particle states are standing waves, and the result is a quasi-Born expansion of K. The equations for passing between schemes (a) and (b) are developed. It is argued that the quasi-particle theory of scheme (b) possesses some advantages of simplicity. (auth)

8699 PHASE TRANSITIONS AND THE DISTRIBUTION OF TEMPERATURE ZEROS OF THE PARTITION FUNCTION. I. GENERAL RELATIONS. Grossmann, S.; Rosenhauer, W. (Philipps-Univ., Marburg, Ger.). Z. Phys., 218: 437-48(1969).

A general method is given by which the density of complex temperature zeros of the canonical partition function, characterizing the temperature behavior of a many-particle system, can be calculated if only line densities occur. As a result it is shown that straight lines of zeros and a simple power law for the line density form a necessary and sufficient description for equal critical in-

dices $\alpha = \alpha'$. The most important conclusion is that different critical indices $\alpha \neq \alpha'$ occur if and only if the line of zeros C cuts the real axis under a certain limiting angle. The difference $\alpha - \alpha'$ is determined by the curvature of C. (auth)

8700 PHASE TRANSITIONS AND THE DISTRIBUTION OF TEMPERATURE ZEROS OF THE PARTITION FUNCTION. II. APPLICATIONS AND EXAMPLES. Grossmann, S.; Lehmann, V. (Phillips-Univ., Marburg, Ger.). Z. Phys., 218: 449-59 (1969).

The general results of paper I are used to discuss the distribution of the complex temperature zeros of the partition function for some realistic physical models. Particular attention is paid to the dependence of locus and number of zeros on specific volume or pressure. (auth)

8701 INTERIOR ELECTRON SHELLS IN SUPERHEAVY NUCLEI. Pieper, W. (Univ. of Virginia, Charlottesville); Greiner, W. Z. Phys., 218: 327-40(1969).

The interior electron shells for superheavy nuclei ($90 \leq Z \leq 250$) were investigated. Their binding energies are tabulated together with the vacuum polarization corrections for the various levels. (auth)

8702 NONLINEAR CYCLOTRON RESONANCE IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE PROPAGATING ALONG A CONSTANT MAGNETIC FIELD. Piliya, A. D.; Fedorov, V. I. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 38: 1032-42(July 1968). (In Russian).

The relativistic motion of a charged particle in the field of a plane circularly polarized electromagnetic wave propagating along a constant magnetic field B_0 is considered. The longitudinal portion of the Lorentz force leads to a Doppler frequency shift of the field acting on the particle. If the phase velocity v_{ph} of the wave equals c, this shift is compensated by a decrease in the ion gyromagnetic frequency, which makes possible continuous resonance acceleration of the particle. If $v_{ph} \neq c$, such compensation is impossible. The equation of motion is solved exactly, and a number of particular cases are considered. For $v_{ph} \neq c$, the amplitude of oscillations of the ion energy and the average energy both decrease with an increase of the initial perpendicular velocity or of the relative frequency difference. The results are used to calculate the current produced by the plane wave in a uniform infinite collisionless plasma. The particle energies increase as a result of the cyclotron heating. The asymptotic form of the energy distribution function for $t \to \infty$ is found. (ATD)

8703 DISTRIBUTION OF POTENTIAL IN A SHORT TUBE OF RECTANGULAR CROSS SECTION WITH A RIBBON BEAM. Barantseva, O. D. (Taganrog Radiotechnical Inst., USSR). Zh. Tekh. Fiz., 38: 268-73(Feb. 1968). (In Russian).

Whereas earlier investigations of this problem were made in a one-dimensional approximation, wherein the thickness of the beam was much shorter than the length and width of the beam, the author determines in this paper the distribution of the potential in a short conducting tube of rectangular cross section with a ribbon beam of rectangular cross section, so that the problem is a three-dimensional one. In determining the potential distribution, it is assumed that the electron beam is in a very strong longitudinal magnetic field, so that the transverse motion of the electrons and the deformation of the beam can be neglected. The space charge is assumed to be uniform over the beam. The distribution is obtained by a standard electrodynamic calculation. A numerical example is presented, and its solution is compared with results obtained by modeling with an electrolytic trough. Agreement is satisfactory. (ATD)

8704 FADDEEV'S EQUATIONS FOR LOCAL POTENTIALS. Osborn, Thomas Arthur. Stanford, Calif., Stanford Univ., 1968. 131p.

Thesis.

The nonrelativistic quantum mechanical three-body problem was studied. The three particle system is that described by three spinless particles interacting via a sum of two-body potentials. The dynamics of the system is determined by Schroedinger's equation. Recently L. D. Faddeev has shown how to re-express this equation in a form which is well defined and avoids the singularities which customarily accompany the three particle Schroedinger equation. Faddeev's work shows that solutions to the problem exist but does not obtain any of these solutions. Subsequent research has obtained specific numerical solutions under the assumption that the two-body potential is separable in momentum space. Mathematically this assumption means that the potential can be written $\langle \vec{p}|V|\vec{q}\rangle = f(\vec{p})h(\vec{q})$. Unfortunately, this assumption has little obvious justification for three-body systems of physical interest. The first aim of this work is to obtain solutions for an arbitrary potential. Secondly, these general solutions were used to test the validity of the assumption that two-body potentials may be represented as separable potentials. (TSS) (Disser. Abstr.)

8705 ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON. Ternov, I. M.; Bagrov, V. G.; Bordovitsyn, V. A.; Dorofeev, O. F. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 2273-80(Dec. 1968). (In Russian).

The magnitude of the anomalous magnetic moment of an electron moving in a stationary and uniform magnetic field is investigated in the first order of the expansion in the fine-structure constant. It is shown that the moment is a complex function of the field strength and particle energy. (auth)

8706 QUANTIZATION OF GENERALIZED MECHANICS. Hayes, C. F.; Jankowski, J. M. (Univ. of Hawaii, Honolulu). Nuovo Cim., 58B: 494-7(Dec. 11, 1968).

It is shown that there is an ambiguity in the theory resulting from the Lagrangian not being unique for a given equation of motion. (M.O.W.)

8707 LORENTZIAN 4 DIMENSIONAL MANIFOLDS WITH "LOCAL ISOTROPY". Cahen, M.; Defrise, L. (Univ. Libre, Brussels). Commun. Math. Phys., 11: 56-76(Nov. 11, 1968).

"Locally isotropic" spaces are defined as spaces in which there exists, in the tangent space at each point P, a subgroup A(P) (of dimension at least 1) of the Lorentz group $L_+^\uparrow$, leaving the Riemann tensor and its 2 first covariant derivatives invariant; the subgroups A(P) are assumed to be conjugate in $L_+^\uparrow$. These spaces admit a group of local isometries G. If I_P denotes the subgroup of G leaving P fixed, then $dA(P) = I_P$. All spaces of petrov type D, admitting local isotropy are determined. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7894.

8708 (NYO-2171-259) THEORETICAL AND EXPERIMENTAL RESEARCH ACTIVITIES IN HIGH-ENERGY PHYSICS. Progress Report, September 1967–September 1968. (Pennsylvania Univ., Philadelphia. Dept. of Physics). Dec. 20, 1968. Contract AT(30-1)-2171. 63p. Dep. CFSTI.

Theoretical research, including elementary particle physics and nuclear structure, and experimental research, including weak and strong interactions, are discussed. Technical developments and experimental support activities are described. Current publications are also presented. (W.H.K.)

Electromagnetic

Refer also to abstracts 8759, 8768, 8769, 8866, 8880, and 8926.

8709 (BNL-12816) ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Cohen, Victor W. (Brookhaven National Lab., Upton, N. Y.). Aug. 30, 1968. 24p. (CONF-680934-1). Dep. CFSTI.

From Conference on Physics of the One and Two Electron Atoms, Munich, Germany.

Various attempts to measure the electric dipole moment of the neutron are reviewed. The principles of the various experiments, their limitations, and a summary of the results are discussed. (L.B.S.)

8710 (ISS-68/15) SEMINAR AT THE PHYSICS LABORATORY DURING THE PERIOD JANUARY–APRIL 1968. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). May 6, 1968. 54p. (In Italian and English). Dep.

Separate abstracts were prepared for two of the fourteen articles presented. (C.E.S.)

For abstracts of individual papers see: 8422 and 8711.

8711 (ISS-68/15, pp 30-44) MEASUREMENTS OF INELASTIC e–p SCATTERING. Ganssauge, E. (Marburg Univ. (West Germany). Physikalisches Institut. Deutsches Elektronen-Synchrtrn, Hamburg (West Germany)).

The process of inelastic e–p scattering for studying the structure of the proton in its resonant states by means of form factors is discussed. CEA, DESY, and Stanford work in this area is considered. (C.E.S.)

8712 (JINR-P1-4077) EXPERIMENTAL INVESTIGATION OF THE DEVELOPMENT OF ELECTRON-PHOTON SHOWERS AT AN ENERGY FROM 1 TO 2 GeV. Ogrzeval'skii, Z.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 26p. (In Russian). Dep.

The electron-photon showers, produced by γ-quanta in liquid xenon, are being investigated with the help of the xenon bubble chamber of the JINR Laboratory of High Energies. Information is obtained about the average shower characteristics at the primary γ-quantum energies of 1000, 1500, and 2000 MeV. (auth)

8713 (TID-24667, pp 113-36) ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. de Vries, C. ([Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)]).

A review of the present insights in the electromagnetic structure of the nucleons is presented. Formulas needed for the analysis of electron scattering experiments, from which the majority of the present knowledge has been obtained, are given. Experimental methods using electron beams are described, and also scattering of thermal neutrons off atoms, proton–antiproton annihilation, proton–proton scattering, and muon scattering experiments are discussed. (W.H.K.)

8714 (TID-24667, pp 287-302) ELECTRON-DEUTERON SCATTERING. Gross, Franz (Cornell Univ., Ithaca, N. Y.).

A review of the status of the experimental and theoretical understanding of the interactions $e + d \rightarrow e + d$ and $e + d \rightarrow e + n + p$ is presented. These interactions are of interest because they provide the best source of information about the neutron form factors and they are used to learn about the two-body nuclear force. (W.H.K.)

8715 (TID-24667, pp 303-16) ELASTIC e-d SCATTERING. Hartmann, G. (Stanford Linear Accelerator Center, Calif.).

Elastic electron–deuteron scattering at high four momentum transfers for small electron scattering angles was studied. Cross sections, deuteron form factors, and other data are presented. (W.H.K.)

8716 (TID-24667, pp 541-54) ELECTROPRODUCTION AT ENERGIES LESS THAN 500 MeV. Berkelman, K. (Cornell Univ., Ithaca, N. Y.).

The interactions $e + p \rightarrow e + n + \pi^+$ and $e + p \rightarrow e + p + \pi^0$ at energies less than 500 MeV are discussed. Possible experiments are considered including photoproduction with transversely polarized virtual photons, longitudinal photon coupling investigations, and nucleon form factors. (W.H.K.)

8717 (TID-24667, pp 574) PION ELECTROPRODUCTION ON NUCLEON. Duclos, J.; Priou, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Two experiments planned at SACLAY on pion electroproduction on nucleons are briefly described. (W.H.K.)

8718 (TID-24667, pp 580) PION PHOTOPRODUCTION ON NUCLEON. Duclos, J.; Priou, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Use of the high intensity MIT and Saclay electron linacs for studying photoproduction of pions on nucleons is discussed. (W.H.K.)

8719 (TID-24667, pp 651-8) PHYSICS WITH LOW ENERGY MUONS. Devons, S. (Columbia Univ., New York).

Possible changes and improvements in some standard muon experiments which may be accomplished with the high-intensity muon beams that are expected from the MIT and Saclay linacs are outlined. Muon–nuclear weak interactions, properties of the muon, electromagnetic properties of muonic atoms, and rare processes such as $\mu^+ + e^- \rightarrow \mu^- + e^+$ are discussed. (W.H.K.)

8720 (UJV-2039) HIGH-FREQUENCY POLARIZATION OF ATOMIC HYDROGEN BEAM. MEASUREMENT OF THE POLARIZATION COEFFICIENT OF PROTONS. Mares, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1968. 23p. Dep.

The polarization of protons takes place by the high-frequency transition between Zeeman levels of atomic hydrogen by using the adiabatic passage method. The polarization coefficient can be found by measuring the beam intensity. In this stage of development, in which it is not possible to test the apparatus by nuclear reactions, intensity measurement methods are the only ones, which permit the beam parameters and function of the apparatus to be judged from qualitative and quantitative aspects. It was found that the method best suited for the determination of the polarization of protons in the hydrogen beam at relatively great distances from the dissociator is the modulated beam method. Some parameters of polarized ion source, which is under construction are also mentioned. (auth)

8721 SINGLE AND DOUBLE PION PHOTOPRODUCTION ON ^{3}He. Goggi, G. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy); Mantovani, G. C.; Piazzoli, A.; Scannicchio, D.; Piazza, A.; Rinzivillo, R. Nuovo Cim., 58A: 901-4(Dec. 21, 1968).

Preliminary results are reported of an experiment of photoproduction on ^{3}He, performed in order to obtain general information about the dynamic behavior of this nucleus up to an energy of 800 MeV of the incoming photon. The experiment was performed by the diffusion cloud chamber technique. Results concerning cross sections per equivalent quantum are presented for photodisintegration reactions and π^+, π^0, π^-, and $\pi^+\pi^-$ photoproduction reactions. (L.B.S.)

8722 RATIO OF π^- TO π^+ PHOTOPRODUCTION FROM DEUTERIUM AT 8 AND 16 GeV. Boyarski, A. M.; Diebold, R.; Ecklund, S. D.; Fischer, G. E.; Murata, Y.; Richter, B.; Williams, W. S. C. (Stanford Univ., Calif.). Phys. Rev. Lett., 21: 1767-70(Dec. 23, 1968).

The ratio $R = [d\sigma(\gamma d \rightarrow \pi^- pp)/dt][d\sigma(\gamma d \rightarrow \pi^+ nn)/dt]^{-1}$ was studied at 8 and 16 GeV for momentum transfers $|t|$ from about 0.001 to 1.3 GeV^2. R is close to unity for $|t| < m_\pi^2$, but falls very rapidly with increasing $|t|$, passing through $\frac{1}{2}$ near $|t| = 0.1$ GeV^2 and having a minimum value of about $\frac{1}{3}$ near $|t| = 0.4$ GeV^2; it slowly increases at larger momentum transfers. These results are similar to those obtained in other laboratories at 3.4 and 5 GeV. This implies considerable interference between the isoscalar and isovector photon amplitudes. (auth)

8723 RHO PRODUCTION WITH POLARIZED PHOTONS. Criegee, L. (DESY, Hamburg); Garrell, M. H.; Gottfried, C.; (and others). Phys. Lett., 28B: 282-6(Dec. 9, 1968).

The process $\gamma + p \rightarrow p + \rho^0 \rightarrow p + \pi^+ + \pi^-$ has been studied with polarized photons between 2.0 and 2.5 GeV. Decay pions and recoil proton were detected with a wire plane system. A strong preference for ρ^0-decay parallel to the polarization vector, expressed by the ratio $\sigma_\perp/\sigma_{||} = 0.17 \pm 0.07$, is found which indicates the predominance of diffractive rho production. (auth)

8724 ELECTROMAGNETIC FORM FACTORS OF THE PROTON BETWEEN 15 AND 50 fm^{-2}. Berger, Chr.; Gersing, E.; Knop, G.; Langenbeck, B.; Rith, K.; Schumacher, F. (Univ., Bonn). Phys. Lett., 28B: 276-8(Dec. 9, 1968).

The external beam of the 2.5 GeV-electron-synchrotron has been used to measure elastic electron proton scattering at four-momentum-transfers between 15 and 50 fm^{-2}. By combining these results with measurements at small angles at DESY, the electric and magnetic form factors were obtained separately. Their ratio shows a deviation from the scaling law. (auth)

Weak

8725 TESTS OF T AND TCP INVARIANCE IN K^0 DECAY. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Nature (London), 220: 1310-13(Dec. 28, 1968).

The observed CP non-invariance in $K^0 \rightarrow 2\pi$ and $K_2^0 \rightarrow \pi l \nu$ decays is usually presumed, on the basis of the TCP theorem, to be associated with T non-invariant interactions, but all experimental searches for specifically T non-invariant processes have so far yielded negative results. Also, in theoretical studies, consideration has been given to situations where the TCP theorem does not necessarily apply. It was therefore of interest to examine the question of T invariance independently of the hypothesis of TCP invariance, while also testing the validity of TCP invariance. As the only known CP non-invariance occurs in K^0 decays, tests based on neutral kaon decay rates are discussed. (UK)

8726 MEASUREMENT OF THE RELATIVE RATE $K_{e3}^+/K_{\mu 3}^+$. Macek, R. (Univ. of Pennsylvania, Philadelphia); Mann, A. K.; McFarlane, W. K.; Roberts, J. B.; Rothe, K. W.; West, C. H.; Auerbach, L. B. Phys. Rev. Lett., 22: 32-4(Jan. 6, 1969).

In an experiment at the Princeton-Pennsylvania Accelerator, the relative rate $K_{e3}^+/K_{\mu 3}^+$ was measured to be $(1.8^{+0.7}_{-0.5}) \times 10^{-5}$. Combining this with previous measurements gives a world average of $(1.9^{+0.5}_{-0.4}) \times 10^{-5}$, which agrees with the universal V–A theory prediction of 2.09×10^{-5}. (auth)

Strong (Baryon-Induced)

Refer also to abstract 8924.

8727 (JINR-P1-4155) PHASE-SHIFT ANALYSIS OF ELASTIC p–p SCATTERING AT AN ENERGY 635 MeV AND INELASTIC INTERACTION CROSS SECTIONS. Zul'karneev, R. Ya.; Kiselev, V. S.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 16p. (In Russian). Dep.

The results of the phase-shift analysis, performed at an energy 635 MeV are presented. The experimental data obtained for the energy range of 635–650 MeV were analyzed. There were obtained several solutions under various assumptions on the meson production. On the basis of the analysis results it was determined that the meson production from $^1D_2$ states is equal to $(15-8)10^{-27}$ cm^2. The contributions into the meson production from ^3P- and ^3F-states are approximately equal and come to $(3-9)10^{-27}$ cm^2 for various sets. The obtained results are compatible with the assumption on the lack of separation of pions with respect to the subsystem of two nucleons. (auth)

8728 PRODUCTION OF THE N*(1470) IN pd → $p_s pp\pi^-$ AT 7.0 GeV/c. Shapira, A.; Benary, O.; Eisenberg, Y.; Ronat, E. E.; Yaffe, D.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 21: 1835-9(Dec. 30, 1968).

A significant peak (M = 1.446 ± 0.011 GeV, Γ = 198 ± 40 MeV), consistent with a I = ½, J = ½ state, is seen in the $p\pi^-$ mass distribution of the reaction pd → $p_s pp\pi^-$ at 7.0 GeV/c. It is interpreted as the N*(1470) produced in the reaction pn → $pN^{*0}(1470)$ [$N^{*0}(1470) \rightarrow p\pi^-$] in deuterium. The production of the N*(1470) is strongly peripheral and favors I = 0 exchange. A discussion of this peak in terms of a double-Regge-pole exchange mechanism is presented. (auth)

8729 $p\pi^+\pi^-$ ENHANCEMENTS IN THE REACTION pp → $pp\pi^+\pi^-$ AT 24.8 GeV/c. Ehrlich, R. (Rutgers–The State Univ., New Brunswick, N. J.); Nieporent, R.; Piano, R. J.; Whittaker, J. B.; Baltay, C.; Feinman, J.; Franzini, P.; Newman, R.; Yeh, N. Phys. Rev. Lett., 21: 1839-42(Dec. 30, 1968).

A study of the reaction pp → $pp\pi^+\pi^-$ at 24.8 GeV/c, based on 3250 events, gives strong support for the production of resonant $p\pi^+\pi^-$ states at 1.423 ± 0.027 and 1.688 ± 0.023 GeV. (auth)

8730 EXPERIMENTAL RESULTS ON $\bar{p}p \rightarrow \eta\pi^+\pi^-$ AND $\bar{p}p \rightarrow X^0\pi^+\pi^-$ FOR ANNIHILATIONS AT REST. Foster, M. (CERN, Geneva); Gavillet, Ph.; Labrosse, G.; Montanet, L.; Salmeron, R. A.; Villemoes, P.; Ghesquiere, C.; Lillestoel, E. Nucl. Phys., B8: 174-82(1968).

In a study of the annihilations at rest $\bar{p}p \rightarrow \eta\pi^+\pi^-$ and $\bar{p}p \rightarrow X^0\pi^+\pi^-$ the following results were found. For $\bar{p}p \rightarrow \eta\pi^+\pi^-$, the rate $(1.51^{+0.3}_{-0.2}) \times 10^{-2}$ from events $\bar{p}p \rightarrow 2\pi^+2\pi^-\pi^0$ and $(1.12^{+0.5}_{-0.3}) \times 10^{-2}$ from events $\bar{p}p \rightarrow \pi^+\pi^-$ (missing mass), the average being $(1.26 \pm 0.13) \times 10^{-2}$. For $\bar{p}p \rightarrow X^0\pi^+\pi^-$, the rate $(2.8 \pm 0.9) \times 10^{-3}$ from the analysis of events $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$ and $(3.3 \pm 0.8) \times 10^{-3}$ from events $\bar{p}p \rightarrow 2\pi^+2\pi^-$ (missing mass), the average being $(3.1 \pm 0.6) \times 10^{-3}$. Ratio $(\bar{p}p \rightarrow \eta\rho^0)/(\bar{p}p \rightarrow \eta\pi^+\pi^-) = 0.51 \pm 0.10$ and $(\bar{p}p \rightarrow X^0\rho^0)/(\bar{p}p \rightarrow X^0\pi^+\pi^-) = 0.46 \pm 0.25$. Searching for resonances decaying into $\eta\pi^\pm$ we find rate of $\bar{p}p \rightarrow (\eta\pi^\pm)(1016) + \pi^\pm < 1.6 \times 10^{-3}$; rate of $\bar{p}p \rightarrow A_2^\pm\pi^\mp$ with $A_2^\pm \rightarrow \eta\pi^\pm$, $< 2.5 \times 10^{-3}$; and the decay ratio $A_2^\pm \rightarrow \eta\pi^\pm/A_2^\pm \rightarrow K^0K^+ < 3$. Rate of $\bar{p}p \rightarrow E^0\pi^+\pi^-$, with $E^0 \rightarrow \eta\pi^+\pi^-$, $< 2 \times 10^{-3}$ and the decay ratio $E^0 \rightarrow \eta\pi^+\pi^-/E^0 \rightarrow K\bar{K}\pi < 1$. (auth)

8731 PROGRAM TO CALCULATE PARTICLE SPECTRA PRODUCED IN HIGH-ENERGY PROTON–PROTON COLLISIONS BY THE TWO-TEMPERATURE STATISTICAL MODEL. Wayland, J. R. (Univ. of Maryland, College Park). J. Comput. Phys., 3: 331(Oct, 1968).

The availability of a program to calculate particle spectra produced in proton–proton collisions above 15 GeV by the two-temperature statistical model is reported. The program is written in both FORTRAN II and IV with function subprograms to compute the required Bessel functions. (C.E.S.)

8732 DIFFERENTIAL PRODUCTION CROSS SECTIONS OF LOW MOMENTUM PARTICLES FROM 12.3 GeV/c PROTONS. Marmer, Gary James. Columbus, Ohio, Ohio State Univ., 1968. 112p.

Thesis.

Measurements of the particle yields and differential production cross-sections of pions, kaons, protons, and antiprotons from 12.3 GeV/c protons incident upon copper, beryllium, polyethylene, aluminum, and lead targets were made at the Zero Gradient Synchrotron at The Argonne National Laboratory. These measurements were taken at production angles between 0 and 11.2 degrees and covered the momentum range 500 MeV/c to 1030 MeV/c. The particles were detected by a time of flight technique, gated by Cerenkov counters in the case of kaons and antiprotons. (Diss. Abstr.)

8733 EVIDENCE FOR PRODUCTION OF AN N*(1400) AND $\bar{N}$*(1400) IN THE REACTION $\bar{p}p(n) \rightarrow \bar{p}p\pi^+\pi^-(n)$ AT 2.8 GeV/c. Bacon, T. C.; Bomse, F.; Borak, T. B.; Cochran, T. B.; Fickinger, W. J.; Goza, E. R.; Hopkins, H. W. K.; Salant, E. O. (Vanderbilt Univ., Nashville). Phys. Rev. Lett., 22: 43-6(Jan. 6, 1969).

In the reaction $\bar{p}p(n) \rightarrow \bar{p}p\pi^+\pi^-(n)$ at 2.8 GeV/c, enhancements in the mass spectra of $\bar{p}\pi^-\pi^+$ and $p\pi^-\pi^+$ were observed near 1400 MeV. Analysis indicates that these enhancements cannot be adequately explained as kinematic reflections of N*(1238) and/or $\bar{N}$*(1238) production. (auth)

Strong (Meson-Induced)

Refer also to abstracts 7736, 7796–7798, and 8818.

8734 (CERN-68-40) STUDY OF THE REACTION $\pi^+ + d \rightarrow p + p$ FOR PIONS WITH ENERGY BETWEEN 143 AND 264 MeV. Richard-Serre, C. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 2, 1968. 86p. (In French). Dep.

The reaction $\pi^+ + d \rightarrow p + p$ has been studied at the 600 MeV synchrocyclotron at CERN. The differential cross-section has been measured for pion laboratory energies of 143, 165, 188, 232, and 264 MeV, which is equivalent, for the inverse reaction ($p + p \rightarrow \pi^+ + d$), to proton laboratory energies of 572, 616, 662, 750, and 815 MeV. The experimental layout is given. Pions produced in a CH_2 target by the external proton beam are directed onto a liquid deuterium target. The two outgoing protons are detected in coincidence, and the energy of the backward-going proton is measured by an 8'' diameter, 8'' long sodium iodide crystal. The correction for the nuclear interactions in the NaI crystal has been calculated and compared to experimental data. The composition of the beam was determined by a Cherenkov counter and corrections applied to the results. The results are

compared with various models; the phenomenological model of Gell-Mann and Watson, the Mandelstam model and the isobar calculations of Tran. None of these models is found to give a completely satisfactory explanation of all the experimental data, although the major features of the reaction seem to be well understood. (auth)

8735 (COO-1764-22) ENHANCEMENTS IN π^-d INTERACTIONS AT 2.26 GeV/c. Benvenuti, A.; Marquit, E. (Minnesota Univ., Minneapolis); Oppenheimer, F. (Colorado Univ., Boulder); Vander Velde, J. C. (Michigan Univ., Ann Arbor). Nov. 1967. Contract AT(11-1)-1764. 13p. (CONF-671122-5). Dep. CFSTI.

From 3rd Topical Conference on Resonant Particles, Athens, Ohio.

Preliminary results are reported of the $\pi^-d \rightarrow (p_s)p\pi^-\pi^-\pi^0$ reaction at 2.26 GeV/c, based on 1718 three- and four-prong interactions in ~30,000 pictures from the 72-inch Alvarez bubble chamber. The π^-p and π^0p effective mass distributions both show enhancements in the region below 1.3 GeV, which become particularly strong for $\Delta^2(\pi^-p) < 0.2$ GeV^2 and $\Delta^2(\pi^0p) < 0.4$ GeV^2, respectively. The $\pi^-\pi^0$ distribution suggests that there is ρ^- production. The $\pi^-\pi^-\pi^0$ distribution without any cuts shows no striking signs of structure. For events in which at least one $\pi^-\pi^0$ pair had an effective mass in the region of the ρ^- meson (0.685-0.85 GeV), the $\pi^-\pi^-\pi^0$ mass distribution displayed two prominent peaks, one at ~0.970 GeV and the other at ~1.080 GeV, with widths of ~80 MeV. No conclusive interpretation is given for the observed enhancements. (L.B.S.)

8736 (JINR-P1-4097) RESONANCE PRODUCTION IN π^+-p INTERACTIONS AT 2.34 GeV/c LEADING TO THREE-PARTICLE FINAL STATES. Angelov, N. S.; Gramenitskii, I. M.; Kanazirski, Kh. M.; Moiseev, A. M.; Tikhonova, L. A.; Fenyuk, A. B.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 30p. (In Russian). Dep.

Quasi two-particle reactions in π^+-p interactions at 2.34 GeV/c, leading to the three-particle final states, are being discussed. The cross sections of the $\pi^+p \rightarrow \rho^+p$, $\pi^+p \rightarrow N^{++}_{1236}\pi^0$, and $\pi^+p \rightarrow N^+_{1688}\pi^+$ reactions have been obtained. (auth)

8737 (NP-tr-1721) SEARCH FOR A BARYON NKπ-RESONANCE WITH STRANGENESS S = +1 IN THE REACTION $\pi^-p \rightarrow NK\bar{K}\pi$ AT INCIDENT π^- MOMENTUM OF 3.25 GeV/c. Vladimirskii, V. V.; Grigor'ev, V. K.; (and others). Translated by D. L. Allan (Atomic Energy Research Establishment, Harwell, Eng.), from report ITEF-584. 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 37079. (C.E.S.)

8738 (TID-24667, pp 575) LOW ENERGY PION–NUCLEON SCATTERING. Duclos, J.; Priou, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

It is pointed out that very little and imprecise data exist on pion–proton scattering below 100 MeV due to the difficulty to obtain low energy pion beams with the synchrocyclotrons but high intensity pion beams are expected from the MIT and Saclay linear accelerators. (W.H.K.)

8739 (TID-24667, pp 576-9) PION–NUCLEON SCATTERING BELOW 100 MeV. Duclos, J.; Priou, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Phase shift analysis of π + N interactions below 100 MeV is briefly discussed. Also, the experimental possibilities of the high-intensity low-energy pion beams expected at the MIT and Saclay linear accelerators are considered. (W.H.K.)

8740 INTERFERENCE ANALYSIS OF THE K*(1400). Antich, P.; Callahan, A.; Carson, R.; (and others) (Johns Hopkins Univ., Baltimore, Md.). Phys. Rev. Lett., 21: 1842-5 (Dec. 30, 1968).

A study of the $K^+\pi^-$ decay mode of the K*(1400) produced with an N^{*++} has been made using the reaction $K^+p \rightarrow K^+\pi^-\pi^+p$ at 5.5 GeV/c. The K*(1400) angular distributions were fitted using a model involving interference between 1^- and $2^+K^+\pi^-$ states. In this model a considerable amount of 1^- is needed in the K*(1400) mass region, suggesting that there is a $J^P = 1^-$ resonance under the K*(1400). Such a $J^P = 1^-$ resonance could be the first daughter of the K*(1400). (auth)

8741 BOSON RESONANCE OF MASS 980 MeV DECAYING INTO $\pi^-\eta$. Ammar, R. (Northwestern Univ., Evanston, Ill.); Davis, R.; Kropac, W.; Mott, J.; Slate, D.; Werner, B.; Derrick, M.; Fields, T.; Schweingruber, F. Phys. Rev. Lett., 21: 1832-5(Dec. 30, 1968).

An enhancement has been observed in the $\pi^-\eta$ system at mass 980 ± 10 MeV with width 80 ± 30 MeV. This boson state, denoted by $\pi_N(980)$, yields a decay angular distribution having about 10% probability for isotropy. It is produced peripherally in the reaction $K^- + p \rightarrow Y^{*+}_1(1385) + \pi_N{}^-(980)$ at 5.5 GeV/c. (auth)

8742 RESONANCE PRODUCTION IN $K^-p \rightarrow K^-p\,\pi^-\pi^+$ NEAR 5.0 GeV/c. Urvater, Ernest Michael. Boulder, Colo., Univ. of Colorado, 1968. 168p.

Thesis.

The reaction $K^-p \rightarrow K^-p\,\pi^-\pi^+$ is studied in 50,000 pictures taken at the BNL 80" liquid hydrogen bubble chamber exposed to incoming kaon beams of 5.0 and 4.6 GeV/c momenta. Seven well established and three or four unconfirmed resonant states are observed in quasi-two and quasi-three body final states. The assumption is made, consistent with the observed production characteristics of the dominant resonant states [K*(890) and $N^{*2+}(1236)$], that the final state under consideration is produced principally by two non-interfering one-pion-exchange (OPE) processes. The two diagrams corresponding to these two processes are calculated under the assumption that the virtual pion scatters quasi-elastically at each vertex of each diagram as if it were on the mass shell. Experimental π^+p elastic scattering data are used for the matrix element at one vertex, while the real Kπ scattering cross sections at the other vertex are paramatrized in terms of a diffraction model. The model calculation is evaluated by a Monte Carlo integration (over 7 variables for each diagram) program and the detailed results are compared to the data with excellent overall agreement. The model predictions are used as an estimate of the background in the complicated low-mass K*π spectrum and production cross sections for two K** resonances are estimated. In a similar manner the branching ratios for K**(1420) → K*(890)π and ρ(760)K are found and compared with the predictions of SU(3). The data are consistent with the SU(3) predictions. Finally, the success of the model in predicting both the shapes of the various distributions and the magnitude of the 4-body production cross section, has made possible a semi-quantitative (model dependent) measurement of the $K^-\pi^-$ elastic and total scattering cross sections averaged over three regions of the $K^-\pi^-$ center of mass energy. (Disser. Abstr.)

8743 THE ANALYSIS OF TWO-PION INTERACTIONS AND ELASTIC SCATTERING IN 2.36 GeV/c π^- + P REACTIONS. Schultz, Ward Edward. Boulder, Colo., Univ. of Colorado, 1968. 96p.

Thesis.

A study is presented of ~22,200 events obtained when negatively charged pi mesons with a momentum of 2.36 GeV/c were incident on a 72-inch hydrogen bubble chamber. The purpose was a large statistics analysis of the production and decay of two-pion resonances in the $\pi^-\pi^0$p and $\pi^-\pi^+$n final states. The elastic scattering reaction was also studied and the differential cross section was determined from 3906 events. The cross sections were calculated for the various reactions initiated by the π^-p interactions. The rho meson was the only two-pion resonance directly observed in the two-pion effective mass distributions. Indirect evidence was found for another two-pion resonance (the ϵ^0) with mass and width approximately that of the rho ($M \cong 765$ and $\Gamma \cong 150$ MeV). This appears to be the most likely explanation for the observed asymmetrical decay of the ρ^0. Although the ρ^- is observed to decay symmetrically in its central mass region, at $M_{\pi^-\pi^0} \cong 800$ MeV it suddenly displays an asymmetry similar to that of the ρ^0. Interference with a nonresonant background qualitatively explains this effect; nevertheless, it is difficult to account for the steepness in the onset of the ρ^- asymmetry. Rho meson production was observed primarily in reactions having a small four-momentum transfer between the incident and final nucleons. These peripheral reactions are believed to be dominated by the one-pion-exchange process. However, results of this experiment imply the existence of other exchange processes. The ratio of ρ^0 to ρ^- cross sections is predicted to be 2.0 for a pure one-pion-exchange production process. The experimental value was found to be about 1.4 ± 0.1 throughout the peripheral region. To account for this discrepancy, an additional ω exchange process for ρ^- production was considered. The reason for the observed constant behavior of the ratio throughout the peripheral region was not apparent. Evidence was found for ω and baryon exchange in nonperipheral ρ production reactions. Although the detailed mechanisms are still uncertain, this data adds considerable credence to these previously discovered features of rho production and decay. A kinematical overlap existed between the ρ and the Δ (1236) mass regions, but the amount of Δ (1236) contamination in the ρ region was found to be small. The mass and width of the ρ^- and ρ^0 were determined for both peripheral reactions and all events. The results were all consistent with the mean values $M\rho = 766 \pm 2$ and $\Gamma\rho = 162 \pm 10$ MeV. (Disser. Abstr.)

8744 HIGH ENERGY π^-p BACKWARD SCATTERING IN REGGE POLE MODEL. Inoue, Hidetoshi; Yamagishi, Kenji;

(Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 40: 834-41(Oct. 1968).

Backward π^-p scattering at 3-8 GeV/c is studied using the Regge pole model by exchanging Δ_δ-trajectory. It is shown that although the energy dependence and the slope of the backward peak for $|u| \lesssim 0.3$ $(GeV/c)^2$ agree with the experimental data, it is difficult to reproduce qualitative experimental feature in the region $|u| \gtrsim 0.3$ $(GeV/c)^2$. Polarization at 8 GeV/c and the masses of parity-doublets with $J^P = 3/2^-$, $7/2^-$ and $11/2^+$ are also calculated by the parameters of Δ_δ-trajectory. (auth)

8745 ANALYSIS OF THE K*(1320) AND L-MESON PRODUCED IN 10 GeV/c K^-p INTERACTIONS. Bartsch, J. (Technische Hochschule, Aachen); Deutschmann, M.; Keppel, E.; (and others). Nucl. Phys., B8: 9-30(1968).

Two $(K\pi\pi)$ enhancements called K*(1320) and the L-meson are observed in 10 GeV/c K^-p interactions, with masses of (1325 ± 6) and (1785 ± 12) MeV and widths of (186 ± 15) and (127 ± 43) MeV, respectively. A peak near 1790 MeV is also observed in the $(K\pi\pi\pi)^-$ mass distribution. Evidence for a $(K\omega)$ decay mode of the L-meson is presented. It is shown that the K*(1320) peak is not a kinematic effect of the Deck-type. A maximum likelihood analysis of the $(K\pi\pi)^-$ channels indicates that the favored spin-parity assignment for K*(1320) is $J^P = 1^+$ (with 2^- less probable) and for the L-meson $J^P = 1^+, 2^-, 3^+ \ldots$. Decay branching ratios into $(K\pi\pi)$, $K\rho$, $K^*(890)\pi$ and $K^*(1420)\pi$ are also obtained for both resonances, as well as their production cross sections. Arguments are given to prove that the isospin of both resonances is $I = 1/2$. All the results are consistent with the interpretation that these resonances are produced by Pomeron exchange. A quark-model speculation leads to a classification of the L-meson as belonging to a nonet with $C = -1$, probably $^3D_2$ or $^1F_3$ in spectroscopic notation. (auth)

8746 EXPERIMENTAL EVIDENCE FOR THE ONSET OF BARYON EXCHANGE IN πp BACKWARD SCATTERING BELOW 3 GeV/c. Banaigs, J. (Department Saturne, Saclay, France); Berger, J.; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F.; Baker, W. F.; Carlson, P. J.; Chabaud, V.; Lundby, A. Nucl. Phys., B8: 31-44(1968).

The results of measurements of π^+p elastic scattering at 2.85, 3.30, and 3.55 GeV/c, and of π^-p at 2.85 and 3.55 GeV/c in the c.m. angular range from 102° to 163° are presented. These results complement previously published data which covered the angular regions from 164° to 176°. The data show that the differential cross sections as a function of u have the same shape as at higher energies, with the pronounced dip at $u = -0.15$ $(GeV/c)^2$ in the case of π^+p. (auth)

8747 STRUCTURE IN DIFFERENTIAL CROSS SECTION DISTRIBUTIONS OF TWO-BODY REACTIONS IN 8 GeV/c π^+p INTERACTIONS. Aderholz, M. (Technische Hochschule, Aachen); Deutschmann, M.; Keppel, E.; (and others). Nucl. Phys., B8: 45-64(1968).

From 60,000 two- and four-prong interactions of 8 GeV/c positive pions in hydrogen, total cross sections have been determined for elastic scattering, for 13 inelastic two-body reactions which represent about 7% of the total cross section, and for the various many-body channels. For elastic scattering and the other two-body reactions, the differential cross section $d\sigma/dt'$ is studied in detail, especially in the forward direction. It is found that (a) in the region near $t' = 0$ a dip is observed in the channels $N^{*++}\eta$, $N^{*++}\omega$ and $p\rho$, and possibly also in $N^{*++}\pi^0$ and $N^{*++}A_2^0$; however, the forward dips predicted by the Regge-pole conspiracy model with factorisation for the channels $N^{*++}\rho^0$ and $N^{*++}f^0$ are not observed, on the contrary $N^{*++}\rho^0$ presents a steep rise near $t' = 0$: (b) at larger t' values, a dip is observed for the $p\rho^+$ channel at about 0.55 GeV^2 and for the $N^{*++}A_2^0$ channel at about 0.45 GeV^2; (c) in general, the $d\sigma/dt'$ distributions can be fitted in the small $|t'|$ region by the function $\exp(-At')$, while over a larger t' range, a fit of the form $\exp(-at' + bt'^2)$ is more satisfactory. However, for the channels $N^{*++}\rho^0$ and $N^{*++}f^0$ a significantly better fit is obtained between 0 and 2 GeV^2 with the sum of two exponentials, $K_1 \exp(-Ct') + K_2 \exp(-Dt')$, with the break point at $|t'| = 0.2$ GeV^2; C is about 15 GeV^{-2}, while D is about 3 GeV^{-2}. The latter is about the same value as obtained for elastic scattering in the t' range from 0.7 to 2.0 GeV^2. (auth)

8748 ENERGY-INDEPENDENT PARTIAL-WAVE ANALYSIS OF $\bar{K}N \to A\pi$ BETWEEN 600 AND 1200 MeV/c. Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Nucl. Phys., B8: 183-94(1968).

The reactions $K^-p \to A\pi^0$ and $K^-n \to A\pi^-$ in the center-of-mass energy range from ≈1.6 to ≈1.9 GeV have been interpreted in terms of an energy-independent partial-wave analysis. Solutions are presented and the possible existence of new resonant states is discussed. (auth)

8749 THE REACTIONS $K^-p \to K^-p$ AND $K^-p \to \bar{K}^0n$ BETWEEN 600 AND 1200 MeV/c. Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Nucl. Phys., B8: 195-204 (1968).

Data on $K^-p \to K^-p$, $K^-p \to \bar{K}^0n$ and on the K^-p total cross section between 600 and 1200 MeV/c are analysed in terms of resonant and non-resonant partial-wave amplitudes. (auth)

8750 STUDY OF THE REACTION $K^-N \to \Sigma\pi\pi$ BETWEEN 600 AND 1200 MeV/c. Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, G.; (and others). Nucl. Phys., B8: 216-22(1968).

The total cross-sections for K^-N collisions leading to $\Sigma\pi\pi$ final states are measured between 0.6 and 1.2 GeV/c and the results are analyzed in terms of the isospin of the $\Sigma\pi\pi$ and $\Sigma\pi$ systems. An upper limit for the decay $\Sigma(1660) \to \Lambda(1405)\pi$ is given. (auth)

8751 PARTIAL-WAVE ANALYSIS OF THE REACTION $K^-p \to \Sigma\pi$ BETWEEN 0.6 AND 1.0 GeV/c. Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Nucl. Phys., B8: 223-31(1968).

Data on the reactions $K^-p \to \Sigma\pi$ are analyzed in terms of partial-wave amplitudes. Results are presented on resonance formation in the mass region 1.6 to 1.8 GeV. (auth)

8752 $K_1^0K_1^0$ THRESHOLD ENHANCEMENT IN $\pi^-p \to K_1^0K_1^0n$ AT 4 GeV/c. Phelan, James Joseph. St. Louis, St. Louis Univ., 1968. 171p.

Thesis.

The reaction $\pi^-p \to K_1^0K_1^0n$ has been studied at 4 GeV/c with special emphasis on the threshold enhancement observed in the $K_1^0K_1^0$ system. The data was obtained using a spark chamber spectrometer at the Zero Gradient Synchrotron at Argonne National Laboratory. The study is based upon approximately two-thirds of the available data, or about 180,000 pictures. The experimental equipment is described. The data reduction is presented in detail; this includes: scanning and measuring, geometrical reconstruction, kinematic fitting, resolution ambiguities, and correction of the data. The interpretation of the $K_1^0K_1^0$ threshold enhancement as a scattering length phenomenon is discussed in detail in terms of the Chew-Low one-pion exchange model and the Dalitz-Tuan multi-channel K-matrix formalism. Analysis in terms of a Breit-Wigner resonance is also presented. The presence of other resonances in the $K_1^0K_1^0n$ final state is commented upon. (Diss. Abstr.)

8753 STRANGENESS S = −2 BARYON RESONANCE. Alitti, J. (Brookhaven National Lab., Upton, N. Y.); Barnes, V. E.; Flaminio, E.; (and others). Phys. Rev. Lett., 22: 79-82(Jan. 13, 1969).

Evidence is presented confirming the existence of the Ξ(1815) baryon with strangeness S = −2 as well as two new Ξ resonances with masses 2030 ± 10 MeV and 2430 ± 20 MeV, respectively. It is speculated that the Ξ(2030) is a member of a $1/2^+$ octet, and an SU(3) analysis of the decay rates of the conjectured states is in reasonable agreement with the experimental data. (auth)

8754 COMPARATIVE STUDY OF THE HYPERFRAGMENTS PRODUCED IN THE INTERACTIONS OF K^- MESONS OF 1.5, 3.0, 5.0, AND 10.1 GeV/c. Bechdolff, Alfred; Baumann, Germain; Gerber, Jean-Paul (Centre de Recherches Nucleaires, Strasbourg. Faculte des Sciences, Nancy. Compt. Rend., Ser. A and B, 267: 828-31(Oct. 14, 1968). (In French).

The characteristics of the hyperfragments were studied as a function of their path and the incident energy. An estimation was made of the mass of the hyperfragments of the different classes. (tr-auth)

8755 STUDY OF THE 1450-MeV $p\pi^+\pi^-$ ENHANCEMENT IN THE REACTION $K^+p \to K^+\pi^+\pi^-p$ AT 5.5 GeV/c. Antich, P.; Callahan, A.; Carson, R.; (and others) (Johns Hopkins Univ., Baltimore). Phys. Rev. Lett., 22: 39-42(Jan. 6, 1969).

A highly peripheral $p\pi^+\pi^-$ enhancement centered near 1450 MeV, observed in $K^+p \to K^+\pi^+\pi^-p$ at 5.5 BeV/c, is shown to be consistent with a $\Delta^{++}\pi^-$ system with $I = 1/2$. A large asymmetry is observed in the $\Delta^{++}\pi^-$ angular distribution which is not consistent with a pure resonant effect. Dissociation-type models fit the data reasonably well when cuts are made on the $K^+\pi^-$ mass, and this is interpreted as evidence for diffractive $K^+\pi^-$ virtual scattering in this $K^+\pi^-$ mass region. (auth)

8756 DETERMINATION OF THE ANGULAR DISTRIBUTION OF π^0 IN THE REACTION $\pi^+ + p \to \pi^+ + p + \pi^0$ BETWEEN 600 AND 1300 MeV. Chavanon, P.; Crozon, M.; Leray, T.; Tocqueville, J. (College de France, Paris). Phys. Lett., 28B: 296-8(Dec. 9, 1968). (In French).

The results of a counter experiment for determining the angular distribution of the π^0 in the reaction $\pi^+,p \to \pi^+,p,\pi^0$ for eight values of the incident energy are presented. (auth)

8757 Kp AND πp BACKWARD ELASTIC SCATTERING AT 5.2 AND 6.9 GeV/c. Baker, W. F.; Berkelman, K.; Carlson, P. J.; (and others) (CERN, Geneva). Phys. Lett., 28B: 291-5 (Dec. 9, 1968).

The angular distributions of K^+p and π^+p backward elastic scattering have been measured at 5.2 and 6.9 GeV/c. Backward π^-p and K^-p elastic scattering were studied at 6.9 GeV/c. Backward peaks are observed in K^+p scattering with an energy dependence of the form s^{-4}. (auth)

8758 PRECISION MEASUREMENT OF THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Bailey, J.; Bartl, W.; Von Bochmann, G.; Brown, R. C. A.; Farley, F. J. M.; Joestlein, H.; Picasso, E.; Williams, R. W. (CERN, Geneva). Phys. Lett., 28B: 287-90(Dec. 9, 1968).

The muon's magnetic moment anomaly, and hence g-factor anomaly $a = \frac{1}{2}(g-2)$, has been measured in the CERN muon storage ring. Final results are $a(\mu^-) - a(\mu^+) = (50 \pm 75) \times 10^{-8}$, and $a(\mu) = (116616 \pm 31) \times 10^{-8}$, which is 1.8 standard deviations above the theoretical value $a_{th}(\mu) = 116560 \times 10^{-8}$. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 8708.

8759 (AED-C-23-31) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 10 (6249-6919). (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 266p.

A list of 671 periodicals, books, conference proceedings, reports, and preprints on high-energy physics received at DESY are presented. Also, an author index, preprint and report number index, and a subject index are included. (W.H.K.)

8760 (COO-1764-10) EFFECTIVE LAGRANGIANS. Gasiorowicz, S.; Geffen, D. A. (Minnesota Univ., Minneapolis). Dec. 1967. Contract AT(11-1)-1764. 97p. Dep. CFSTI.

An attempt is made to show in detail the method of construction of phenomenological Lagrangians which exhibit chiral symmetry broken in a way which leads to the PCAC condition, with currents that are proportional to vector fields. The system of spin 0 and spin 1 mesons is considered. In successive sections the following are discussed: (I) the Lagrangian formalism; (II) chiral symmetry for pions including both the linear and nolinear realizations of the symmetry; (III) vector mesons and the form of the coupling that leads to field algebra. In section IV it is shown how to couple spin 0 mesons and vector mesons so as to preserve field algebra. The predictions for the $\rho\pi\pi$ and $A_1\rho\pi$ system are worked out in section V. The generalization of the formalism to SU(3) × SU(3) is discussed in section VI. In section VII the formalism is applied to a discussion of pseudoscalar mesons. (L.B.S.)

8761 (INP-622(Vol.1)) PROCEEDINGS OF THE VIII CRACOW SCHOOL OF THEORETICAL PHYSICS. (Institute of Nuclear Physics, Krakow (Poland)). July 1968. 146p. Dep.

Separate abstracts were prepared for the seven lectures included in Vol. I. (L.B.S.)

For abstracts of individual papers see: 8762, 8795, 8805–8807, 8850, and 8851.

8762 (INP-622(Vol.1), pp 28-38) SOME PHENOMENOLOGICAL IMPLICATIONS OF THE REGGE POLE MODEL. Salin, Philippe (European Organization for Nuclear Research, Geneva (Switzerland)).

It is shown that the cross section for any quasi two-body reaction can be split in a model independent way into natural and unnatural parity parts. Applications are made to photoproduction experiments and baryon resonance production. Implications of evasion and conspiracy are discussed. (L.B.S.)

8763 PARTICLE MULTIPLICITY IN HIGH-ENERGY COLLISIONS. Pinski, G. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 58A: 888-90(Dec. 21, 1968).

It is shown that if the fireball decay is described by the covariant statistical model, the observed $E_L^{\frac{1}{4}}$ law ($\langle n \rangle \approx 3E_L^{\frac{1}{4}}$) for the multiplicity of secondaries follows, as does the constancy of the energy of the secondaries in the fireball rest system. The average number of particles produced at high energies from an available center-of-mass energy is calculated according to the covariant statistical model. The dependence of the fireball mass upon the incident energy is then found. (L.B.S.)

8764 C, P, T, AND GENERAL FIRST AND SECOND ORDER PARTIAL DIFFERENTIAL RELATIVISTIC WAVE EQUATIONS. Lam, Yuk-ming P. (Univ. of Chicago). Contract AT(11-1)-264. Ann. Phys. (N.Y.), 50: 323-54(Nov. 1968).

The extended Lorentz group, which contains space and time inversions, is extended by the two element group Z_2; so that representations of the resulting group, called the full Lorentz group $\bar{L}$, describe integral or half integral spin states. Some of these representations are finite-dimensional, while others have infinite dimensions. The full Poincare group $\bar{P}$ is constructed as the semiproduct of $\bar{L}$, with the translational group T. The main hypothesis is that single particle systems form representations of $\bar{P}$. First or second order partial differential relativistic wave equations are used to project out those subspaces to whose vectors single physical particle states may be assigned. Under a set of hypotheses originating from heuristic arguments, solutions of wave equations are shown to possess the transformation properties of free partial states under $\bar{P}$, so that the assignment of physical states to solutions is meaningful. Since parity and time-inversion are elements of $\bar{P}$, wave equations are automatically invariant under them. Parities of particles are found to be ±1 or ±i. A "Poincare invariant" exists so that distinct particle states are orthogonal. In all those equations having particle anti-particle pairs, a charge conjugation operator can always be defined. (auth)

8765 VARIATION OF EXPONENTIAL DECAY OF EXCITED STATES. Ingolfsson, Ketill (Univ., Zurich). Commun. Math. Phys., 11: 168-80(1968). (In German).

In the theory of line breadth phenomena excited amplitudes must not exactly follow the usual exponential decay law. This fact is well known from fundamental mathematical considerations, although there is not any unique form for the corresponding deviation. A search is made for a new expression for the decay, based upon a rather general field model of mass zero. The result is a good approximation for times $\sim 1/\gamma$ and yields the exact asymptotic solution. A modification to a model with mass ≠ 0 does not in general lead to other formulations of the solution. (auth)

Electromagnetic

Refer also to abstracts 8713, 8714, 8716, and 8809.

8766 (JINR-P2-4047) REMARKS ON THE ELECTROMAGNETIC INTERACTIONS OF $K^0_{1,2}$-MESONS. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 8p. (In Russian). Dep.

Three remarks are discussed on the electromagnetic interaction of $K^0_{1,2}$-mesons. The first two remarks refer to K^0_1-meson regeneration on electrons. The contribution of regeneration on electrons can be observed when the value and the sign of the lepton asymmetry in K^0_{l3} decays after the regenerator are observed. The general expression for the K^0-meson electromagnetic current and for the amplitude of K^0-meson electromagnetic interaction with electrons is not changed with the account of CP-invariance violation. It is known that the electromagnetic interaction causes $K^0_2 \to K^0_1$ transitions but does not make any contribution (in e^2-approximation) to the $(K^0_{1,2}) \to (K^0_{1,2})$ transitions. (Here $K^0_{1,2}$ are understood as eigenstates of the CP-parity.) In violating the CP-invariance $K^0_{1,2}$ becomes physical states instead of $K^0_{1,2}$. Then we have not only $K^0_{1,2} \to K^0_{1,2}$ transition but also $K^0_{1,2} \to K^0_{1,2}$ transitions whose amplitude (in e^2-approximation) is 10^{-3} of the non-diagonai transition amplitude. Detailed formulae for the general case, when CPT-invariance is valid, and when T-invariance is valid are given. (auth)

8767 (LAL-1204) COMPARISON OF ORSAY RESULTS ON VECTOR MESONS WITH THE VECTOR MESON DOMINANCE MODEL PREDICTIONS. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov. 1968. 13p. Dep.

Results of the three Orsay experiments are analyzed in the vector meson dominance hypothesis. The coupling constants of ρ^0, ω^0 and ϕ^0 mesons to the photons are determined, and the mixing angle θ_Y and θ_N of the ω^0 and ϕ^0 mesons are calculated. The values are compared to various theoretical predictions. (auth)

8768 (TID-24667, pp 523-40) PHOTO- AND ELECTRO-PION PRODUCTION FROM THE NUCLEON. Donnachie, A. (Glasgow Univ. (Scotland)).

A review of research on photoproduction and electroproduction of pions from the nucleon is given. Also, nucleon Compton scattering in the region of the first resonance, the isobar model, T-violation and its observation in the region of the first resonance, and pion–nucleon phase shift analysis are discussed. (W.H.K.)

8769 (TID-24667, pp 567-73) PROTON COMPTON EFFECT TO 400 MeV. Patel, P. M. (Massachusetts Inst. of Tech., Cambridge).

The elastic scattering of low energy (< 400 MeV) photons from protons is studied. Kinematics, the low energy theorem, dispersion relations: forward amplitudes, sum rules, vector dominance, and the present experimental situation and attempts at theoretical interpretation are briefly discussed. (W.H.K.)

8770 (UCSD-10-P-10-48) ELECTROMAGNETIC INTERACTIONS: THEORY. Kroll, N. M. (California Univ., La Jolla, San Diego). Sept. 1968. Contract AT(11-1)-Gen-10. 35p. (CONF-680809-38). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austira.

The discussion is devoted mainly to the following topics: the asymptotic behavior of form factors as evidence of composite structure; excitation of resonances in inelastic electron-proton scattering; inelastic electron-proton scattering at high energies and the Bjorken sum rule; vector dominance in the electromagnetic interactions of hadrons; and electromagnetic mass differences in isotopic multiplets. (L.B.S.)

8771 ON THE SOFT-PION TECHNIQUE APPLIED TO BREMSSTRAHLUNG PROCESSES: $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$. Ferrari, R. (Univ., Pisa, Italy). Nuovo Cim., 58A: 898-900(Dec. 21, 1968).

It is shown that the usual soft-pion technique cannot be applied straightforwardly to the case of $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$, and in particular that the off-mass-shell extrapolation for the pion is not possible because of the infinite-range character of the electromagnetic forces. It is shown by a simple example that the amplitude obtained from current algebra, PCAC, and soft pion all together cannot be used as the physical amplitude. It is suggested that the standard theory of soft photons should be used for $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$. (L.B.S.)

8772 ISOBAR PHOTOPRODUCTION AND VECTOR DOMINANCE. Sundaram, A. (Inst. of Mathematical Sciences, Madras). Nuovo Cim., 58A: 905-7(Dec. 21, 1968).

An attempt is made to test the vector-dominance assumption for the hadron electromagnetic current by applying it to the case of $\gamma + p \rightarrow \pi^- + \Delta^{++}$ with the Regge-pole model as underlying dynamics. The analysis reveals reasonable agreement with experimental data not only in absolute magnitude but also in the variation of $d\sigma/dt$ with t in the range $0.2 < -t < 0.5$. (L.B.S.)

8773 OVERLAPPING FINAL STATE INTERACTIONS. Mak, William Hung-ying. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 90p.

Thesis.

Following the dispersion theory model of three-body production and decay processes developed by Aitchison, an approximate iterative solution is formulated. The criterion for rescattering and the interpretation of the singularities after each iteration are the same as Bronzan's. This is then extended to the evaluation of the γ-3π vertex, which occurs in the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^- + \pi^0$. By assuming first a one-dimensional representation for the two-body π-π channel, an analog of the Aitchison's equation is derived. Within such framework, this process is found to be a one-final-state-interaction type. Some assumptions of other authors turn out to be a natural consequence of our equation. The Khuri-Treiman equation, on which the Aitchison equation is based, can be generalized to all angular momentum. It is found that the pure kinematical effects due to higher spin cannot be ignored in the rescattering region. In order to make the three-pion system more amenable to numerical analysis, an integral equation is derived using a p-wave dominance in each two-body channel. (auth) (Disser. Abstr.)

8774 ELASTIC SCATTERING OF γ-QUANTA ON PROTONS AT ENERGIES ABOVE THRESHOLD OF π MESON PHOTOPRODUCTION. Sokol, G. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 41: 60-145(1968). (In Russian).

General data are given on the elastic scattering of γ quanta on protons studied during 1959 to 1964. A brief review is given of the theoretical and experimental data on the angular distribution of Compton effect cross sections at γ-quantum energies above the threshold of meson production. The Compton effect on protons is analyzed and various instruments, geometry, and conditions for measuring the yield, and performance of synchrotrons and γ beams are described. The method for effective recording of p-γ coincidences and characteristics of electronic devices are reviewed. Calculations of differential Compton-effect cross sections according to the measured yields, and calculations of binary reaction cross sections according the yield of charged products are included. Statistical treatment of p-γ coincidences and the approximations obtained for the angular dependence of Compton effect differential cross sections and the total cross sections for γ-quantum energies at 214 and 249 MeV are analyzed. Results obtained are compared with published experimental and theoretical data using binary dispersion relations. The theoretical data offer the sign of the amplitude corresponding the pole diagram with π^0 meson. 102 references are included. (R.V.J.)

8775 TWO-PHOTON INTERACTIONS OF ELEMENTARY PARTICLES AT LOW ENERGIES. Petrun'kin, V. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 41: 165-223(1968). (In Russian).

Two-photon interactions of elementary particles are briefly reviewed. The first chapter of the review includes the expressions and analysis of amplitudes of γ-quantum scattering on particles with 0 and $\frac{1}{2}$ spins (considering effects of particle electromagnetic structure) and the analysis and interpretation of data on γ quantum scattering on elementary particles at low energies. The numerical magnitudes of α and β proton parameters (α and β coefficients of electric and magnetic polarization) were obtained by comparison of theoretical formula for differential cross section of γ-quantum scattering on protons with the experimental data and theoretical evaluation was made of the π- and K meson magnetic dipole polarization. The second chapter of the article reviewed the S matrix elements in Heisenberg principle for neutron scattering by nuclear Coulomb field. The relativistic and structural corrections are given for Schwinger formula related to the single-photon exchange and the polarization effect of electron-positron cloud surrounding neutron is evaluated. The corrections for the energy levels in hydrogen and deuterium atoms (ordinary atoms and μ-mesoatoms) produced by nuclear polarization in electron electric field are calculated. For hydrogen atoms the calculated correction was by three orders of magnitude smaller than the experimental error measured by Lamb shift, and for deuterium it was about identical to the order of experimental error. In the case of μ-mesons the corrections for polarization are of relatively higher importance. 68 references are included. (R.V.J.)

8776 ANALYSIS OF DISPERSION RELATIONS FOR ELASTIC γ QUANTUM SCATTERING ON NUCLEON. Fil'kov, L. V. Tr. Fiz. Inst., Akad. Nauk SSSR, 41: 3-59(1968). (In Russian).

A brief review is given of γ-quanta interactions with nucleons. Kinematics of elastic γ-quantum scattering and dispersion relations for Compton scattering on nucleons are discussed as well as one dimensional dispersion relations constructed with fixed t without substraction. One-dimensional dispersion relation with substraction, obtained on the basis of binary dispersion, and virtual amplitude of elastic quantum scattering are analyzed. The influence of spin structure of the process on the dispersion equations for $T_i(s,t)$ amplitudes is reviewed and numerical analysis is made of dispersion equations. Graphical data are included on the energy dependence of differential cross sections of Compton scattering on protons at 0°, 75°, 90°, and 135° angles. The angular dependence of Compton scattering on protons at the incoming proton energy of 60, 213, 260, 280, 300, and 330 MeV is also discussed. 59 references. (R.V.J.)

8777 PHOTO-, ELECTRO-, AND WEAK SINGLE-PION PRODUCTION IN THE (3,3) RESONANCE REGION. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N.Y.), 50: 189-311(Nov. 1968).

A unified account is given of single-pion photo-, electro-, and weak production. The emphases of the paper are fourfold: (1) a detailed kinematic discussion of single-pion electro- and weak-production is given; (2) a dynamical model for electroproduction and weak production in the (3,3) resonance region is developed, based on the CGLN model for photoproduction; (3) the partially conserved axial-vector current (PCAC) and current-algebra constraints which relate the single-pion electro- and weak-production matrix elements to the matrix elements for other processes are systematically discussed; (4) the model is compared with experiment. (auth)

8778 ON THE ASYMPTOTIC BEHAVIOR OF ELECTROMAGNETIC FORM FACTORS. Yamada, Masao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 848-63(Oct. 1968).

Electromagnetic form factors for composite particles are discussed. It is shown that the form factor of π-meson behaves like $(\log t)^n/t^2$ (n = 1 or 2) for the large positive momentum squared t when the π-meson is assumed to be a bound state of the nucleon and anti-nucleon system. For the spinless nucleon this is verified without any approximation other than the B-S equation with a general kernel and for this case it is shown that n = 1. Some approximations are taken when the spin of the nucleon is included, and it is found that n = 2 for this case, but it is argued that this conclusion may be true in general. Some discussions of the large t behavior of the form factor of nucleon in a bound state are added. (auth)

8779 NUCLEON–NUCLEON BREMSSTRAHLUNG. Pearce, William Albert. Houston, Tex., Rice Univ., 1968. 145p.
Thesis.

A potential model was used to calculate nucleon-nucleon bremsstrahlung cross sections. The Tabakin separable potentials and an off-shell one-pion-exchange model (accounting for all partial waves) within the Goldberger–Gell-Mann two potential formalism were used. It was found, in contrast with earlier work, that the ppγ cross sections can be quantitatively explained within the framework of existing theory. Theoretical predictions of the ppγ cross sections are compared with existing experimental values for bombarding energies between 46 and 204 MeV and for two experimental geometries. The agreement is excellent. The importance of the higher partial waves and of the off-shell character of the nuclear model interaction is examined. It is found that present experimental errors prohibit precise determination of the off-shell behavior of the nuclear interaction. The npγ cross sections are calculated for those energies and geometries for which the ppγ cross sections have been observed. The neglect of rescattering terms and of partial waves for L > 2 hampers the precision of these calculations. It is expected that accounting for these neglected terms would raise the npγ cross sections into agreement with recent experimental results. (TSS) (Disser. Abstr.)

8780 THREE-PION DECAYS OF η AND K AND THE FINAL STATE INTERACTIONS. Kanazawa, Akira; Kariya, Tadaaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 40: 842-7(Oct. 1968).

The three-pion decays of the η and the K mesons are simultaneously investigated in the light of new data and in terms of the conventional pion pole model. The final state interactions are assumed to be dominated by the well-established ρ meson. It is found that one can obtain a surprisingly good agreement with all the recent data of the η and the K-meson decay spectra and the branching ratios including $\Gamma(\eta \to 3\pi^0)/\Gamma(\eta \to \pi^+\pi^-\pi^0)$ if we put $\lambda = -0.19$, where λ is the coupling constant of the four-pion interaction and where λ is the only parameter adjusted to fit these quantities. A discussion is also made about the magnitude of the $\eta \to \pi$ and the $K \to \pi$ transitions in relation to the absolute decay rates. (auth)

8781 FIELD–CURRENT IDENTITY AND VACUUM POLARIZATION EFFECTS OF HADRONS. Etim, E.; Picchi, P. (CNEN, Frascati, Italy). Phys. Lett., 28B: 272-5(Dec. 9, 1968).

Vacuum polarization effects of hadrons are calculated in the vector dominance approximation and an application is made in evaluating $\rho^0 - \omega$ interference in the process $e^+ + e^- \to \pi^+ + \pi^-$. (auth)

8782 ON THE ELECTROMAGNETIC MASS DIFFERENCES OF π AND K. Miura, Kimio (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 40: 897-8(Oct. 1968).

It is shown that the electromagnetic mass differences of psuedoscalar mesons may be understood by introducing the $V\pi\gamma$ and $A\pi\gamma$ vertices, which correspond to the Feynman–Speisman theory in the quark model. (L.B.S.)

8783 PION FORM FACTOR AND THE SECOND ρ MESON. Ito, Tadaei; Narita, Takao (Tohoku Gakuin Univ., Tagajo, Japan). Progr. Theor. Phys. (Kyoto), 40: 911-12(Oct. 1968).

It is shown that the analysis of the pion charge form factor in the Regge pole model requires the existence of a second meson. Previous data of the positive pion charge form factor from the $e + p \to e + n + \pi^+$ interactions were analyzed by the least square fit. The second ρ meson Regge trajectory is introduced via the McMillan–Predazzi form generalized by Drummond. (L.B.S.)

8784 COMPTON SCATTERING, RADIATIVE PROCESSES, AND THE SPECTRAL FUNCTION SUM RULES. Chanda, Rajat. Rochester, N. Y., Univ. of Rochester, 1968. 166p.
Thesis.

Processes involving real and virtual photons were studied. Forward Compton scattering sum rules from hadrons were studied in some detail. The validity of fractionally and integrally charged quark models of elementary particles is also investigated by studying the model dependent equal time commutation relations involving space–space components of electromagnetic currents. First, we discuss the Compton scattering from the vector meson octet and baryon decuplet. An appropriate linear combination of Compton amplitudes is considered which vanishes in the high energy limit so that one can write down an unsubtracted dispersion relation for the combination. The optical theorem is used to relate the imaginary part of the forward amplitude to the total Compton cross section. The low energy Thomson limit depends only on the charge and mass of the target. Dispersion relations coupled with this low energy theorem gives interesting sum rules involving photon energy integrals over total cross sections. Useful information may be extracted only through the assumption that the integrals are dominated by a few low lying poles. This "saturation assumption" yields simple algebraic sum rules involving masses and radiative decay widths. Combined with the U-spin invariance of electromagnetism six radiative decay widths of $3/2^+$ particles were obtained which has been summarized. Also several sum rules involving vector meson radiative decay widths and the magnitude of $\Gamma(\rho \to \eta\gamma)$ are written down. Next, the virtual photon-pion forward scattering sum rules are studied. First, low energy theorems are obtained by means of the usual soft pion techniques of current algebra coupled with the PCAC condition and the spectral function sum rules of Weinberg. A spacial combination of amplitudes is chosen and unsubtracted dispersion relations are assumed. The dispersion sum rules thus obtained are then tested by trying to saturate them with low lying poles such as π, ω, θ, A_1 and A_2. It is found that the sum rules are inconsistent with the three point vertex sum rules derived by several authors unless intermediate states with spins 2 or higher are taken into account. Thus the π-γ scattering sum rules are slowly convergent. Our sum rules hold for all q^2 where q is the photon four momentum and the Pagels sum rule is obtained as a special case. The absence of the double pole at m_ρ^2 in the recent soft pion calculation of $\pi^+ - \pi^0$ mass difference in contrast with the older calculations is also clarified. The sum rules obtained by replacing vector currents by axial vector currents are also investigated. Again, the low convergence of these sum rules is demonstrated. Finally, the problem of $\pi^0 \to 2\gamma$ is studied in order to test models of elementary particles since model dependent current commutators enter in this problem. In the soft pion limit, one can write down a spectral representation for three point functions analogous to the Lehmann–Källen representation and obtain a spectral function sum rule involving a model dependent parameter which is utilized to calculate $\Gamma(\pi^0 \to 2\gamma)$. The PCAC hypothesis is not used. The sign of γ is calculated which is the ratio of the structure dependent vector and axial vector form factors in the problem of $\pi^\pm \to l\,\nu\gamma$ decay. The decay rate test and the sign of γ seems to prefer the integrally charged quark model but the model considered by Cabibbo et al. gives wrong sign for $\pi^0 \to 2\gamma$ amplitude. (Diss. Abstr.)

Weak

Refer also to abstract 8777.

8785 (JINR-P2-4082) EXCLUSION OF ONE TYPE OF NONEXPONENTIALITY FOR K^0-MESON DECAY. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 12p. (In Russian). Dep.

It is shown that the discovery of nonzero charge asymmetry in $K^0_{l_3}$ decays at long distances after the target, where K^0 is produced, proves directly that high pole nonexponentiality of Goldberger-Watson (G-W) type is excluded for K^0 decays. It is shown that CPT- and T-symmetry conditions remain the same for any deviations from the exponential decay law. For the case of any nonexponentiality the expressions for the time dependence of amplitudes T^+ and T^- with the emission of l^+ and l^-, respectively, ($l = e,\mu$) are given. At long distances after the target usual expression for asymmetry α remains valid, when CPT-invariance and the rule $\Delta Q = \Delta S$ are valid. Previously it was proved from the Bell-Steinberger (B-S) type unitarity relation that for the high pole G-W case the states $|K^0_L>$ and $|K^0_S>$ are orthogonal without any relation to CP-invariance. It is clear that this formal possibility is excluded for K^0-decays. Experimental investigations of the time dependence of leptonic asymmetry at different distances after the target gives direct information about the exact form of time-dependence. In the case of the $\Delta Q = \Delta S$ rule violation the existing experimental data can eliminate the possibility of high pole description of the G-W type for K^0-decay. The general form of the B-S unitarity relations is considered in the Appendix. Relations for the generalization of B-S relations for the case when the exponential law is not valid are given. It is interesting to note that the probabilities for any G-W type decays vanished at $\tau = 0$. Total probabilities are asymptotical when $\Gamma_t \to \infty$ goes to Γ. (auth)

8786 (JINR-P2-4120) ON THE EFFECTS OF THE CLASHING μ-MESON BEAMS. Tikhonin, F. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 14p. (In Russian). Dep.

Possible effect of the weak interaction on the $\mu^+ + \mu^- \to \mu^+ + \mu^-$ scattering and the $\mu^+ + \mu^- \to e^+ + e^-$ reaction, both through the neutral lepton currents and the charged ones (in the second order on weak constant), is being considered. The calculations show that P-odd effects in the mentioned processes would prove the existence of the neutral currents which, in their turn, give the principal basis for explanation of the mass difference of a muon and an electron. (auth)

8787 FINAL-STATE INTERACTION ENHANCEMENTS IN WEAK THREE-BODY DECAYS. Amado, R. D.; Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 21: 1846-8(Dec. 30, 1968).

Decay-rate enhancements are calculated in an exactly soluble model of a weak decay into three hadrons. Very large enhancements and de-enhancements can be produced by a purely attractive, moderately strong, pairwise, final-state interaction. The enhancements are also very sensitive to the localization of the bare weak-decay amplitude. (auth)

8788 K_{l3} FORM FACTORS AND THE KAPPA-MESON. de Alwis, S. P.; Nutbrown, D. A. (Univ. of Cambridge, Eng.). Nuovo Cim., 58A: 876-81(Dec. 21, 1968).

A method for estimating corrections to the low-energy theorems of current algebra and PCAC has been extended to the case of three-point functions and applied, in particular, to the case of K_{l3} decay. Additional information is obtained about the K_{l3} form factors using this method, by making a specific assumption about the $SU_3 \times SU_3$ symmetry-breaking part of the Hamiltonian. The current-divergence commutator is calculated, which enables two relations to be obtained, one involving the on-shell K_{l3} form factors evaluated at $k^2 = -(m_k - m_\pi)^2$, just inside the physical region, and the other involving the form factors at $k^2 = -(m_k + m_\pi)^2$, which is outside the physical region. (L.B.S.)

8789 VIOLATION OF THE CP-PARITY IN HADRON DECAY FORMING LEPTON PAIRS. Agamaliev, A. K.; Sadykhov, F. S. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 3-6(1968). (In Russian).

The possible violation of CP(or T)-parity in weak hadron decay $A \rightarrow B + l^+ + l^-$ was studied using the Salzman et al., (Phys. Lett, 15: 91(1965)) model. The calculations were carried out in polar approximation, i.e., assuming that one photon exchange between hadron and electron currents. General equations were obtained for magnitudes measured as functions of B-particle polarization and electric dipole moment of the intermediate vector meson with integration using spin lepton and antilepton states. (R.V.J.)

8790 LEPTONIC DECAY OF HADRONS AND THE THIRD-NEUTRINO THEORY. Romanov, Yu. I. (Inst. of Medical Radiology, Moscow). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 91-3(1968). (In Russian).

Although at the present it is not possible to obtain "hadron" neutrino beams from lepton decays of hadrons, it is reasonable to expect the creation of high-intensity charged-particle beams which generate neutrinos by the decay of K mesons, and of high-energy neutrinos from the decay of hadrons formed in the atmosphere by cosmic-ray protons. Recent experiments at CERN pointed out the possibility of generating 4 to 9 GeV neutrinos from kaon decay. Lepton decay of hyperons is probably accompanied by the emission of hadron-type h neutrinos (antineutrinos) which differ from electron or muon neutrinos. In the theory of the four-component Dirac neutrino it is assumed that the electron and hadron neutrino are levorotatory and the muon neutrino is dextrorotatory. Examination of the lepton polarization processes indicated that the helical properties of the electrons (positrons) generated are opposite to those of the hadron neutrino (antineutrino). Thus, in agreement with experimental evidence, the electrons formed by the lepton decay of hadrons are left-polarized and the positrons are right-polarized. (TTT)

8791 SUBTRACTIONS AND OFF-SHELL CONTINUATION OF WEAK FORM FACTORS. Dahmen, H. D.; Rothe, K. D.; Schuelke, L. (Univ., Heidelberg). Nucl. Phys., B8: 150-8(1968).

The dependence of the weak form factors on the mass variables is studied in the one-particle approximation, taking the K_{l3} form factors as an example. The off-shell continuation considered is the same as in soft-pion calculations. The off-shell dependence is obtained in terms of the subtraction constants of the matrix elements of the axial vector current A^{π^0} and strong coupling constants. Under the assumption of unsubtracted dispersion relations the correction to the soft-pion result is estimated to be small. (auth)

8792 PREDICTION OF Re ϵ FROM K_{l3} DECAYS IN AN EXTENDED CABIBBO MODEL. Bender, L.; Linke, V.; Rothe, Heinz J. (Univ., Heidelberg). Z. Phys., 218: 217-22(1969).

With the help of an extended Cabibbo model for the weak hadronic vector current which includes the 10 and $\overline{10}$ representations to account for possible $\Delta S = -\Delta Q$ transitions, a prediction is made for the quantity $(1-|x|^2)/|1-x|^2$ where $x = A(K^0 \rightarrow \pi^+ e^- \bar{\nu})/A(\bar{K}^0 \rightarrow \pi^+ e^- \nu)$ using the experimental branching ratio $\Gamma(K^- \rightarrow \pi^0 e^- \bar{\nu})/\Gamma(K_2^0 \rightarrow \pi^+ e^- \bar{\nu})$. From the known charge asymmetry in the decay of the long lived kaon one then obtains Re ϵ. (auth)

8793 NOTE ON THE EFFECTIVE HAMILTONIAN OF NON-LEPTONIC HYPERON DECAYS. Koide, Yoshio (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 40: 898-900(Oct. 1968).

Nonleptonic hyperon decays are examined in the quartet model, assuming that the decays are caused by combinations of strong interactions and weak two-body transition between the urbaryons t_2 and t_3. Two types of interactions are obtained, and it is shown how one type contributes to the s-wave decays and the other to the p-wave decays. (L.B.S.)

Strong (General)

Refer also to abstracts 8781 and 8837.

8794 (COO-1764-1) V-N POTENTIALS IN THE LEE MODEL. Bolsterli, M. (Minnesota Univ., Minneapolis. School of Physics). Sept. 1967. Contract AT(11-1)-1371. 19p. Dep. CFSTI.

The interaction between a V and N is considered in the adiabatic approximation. As in proton-hydrogen scattering, the interaction involves two potentials. The potentials are given for one specific model to illustrate the general nature of the results. (L.B.S.)

8795 (INP-622(Vol.1), pp 39-74) QUARK MODEL. Bialas, Andrzej (Jagellonian Univ., Krakow (Poland). Inst. of Physics. Institute of Nuclear Physics, Krakow (Poland)); Zalewski, Kacper (Institute of Nuclear Research, Krakow (Poland)).

The application of the quark model to two-body scattering processes is reviewed. The following topics are discussed: wave functions of particles in terms of quarks; small angle scattering; large angle scattering; backward scattering; form factors; symmetry; and some detailed results of the quark model. (L.B.S.)

8796 STATISTICAL THERMODYNAMICS OF STRONG INTERACTIONS AT HIGH ENERGIES. II. MOMENTUM SPECTRA OF PARTICLES PRODUCED IN pp-COLLISIONS. Hagedorn, R.; Ranft, J. (CERN, Geneva). Nuovo Cim., 6: Suppl., 169-310(1968).

An attempt is made to work out a realistic and reliable model of the production processes in high-energy hadron-hadron collisions, dealing specifically with multiplicities, energy and angular distribution of secondaries from pp collisions. Section 1 gives a summary description of the model; the details of the kinematical-thermodynamical model are presented in section 2. Section 3 deals with the parameters and numerical procedure. Section 4 reports the results and compares them to the experiment. Section 5 concludes with a discussion and appraisal of the model, including further developments. Five appendices are included, which deal with the partition function; the temperature-energy relation; invariant mass distribution and locality of conserving laws; isobar decay and effective temperature; and the Lorentz-transformation of momentum spectra. (L.B.S.)

8797 STATISTICAL THERMODYNAMICS OF STRONG INTERACTIONS AT HIGH ENERGIES. III. HEAVY-PAIR (QUARK) PRODUCTION RATES. Hagedorn, R. (CERN, Geneva). Nuovo Cim., 6: Suppl., 311-354(1968).

The thermodynamic model previously formulated is used for calculating the production rate of heavy particles, in particular of those which must be created in pairs because of a charge-type conservation law. The considerations are general, although application is made throughout to quark production. (L.B.S.)

Strong (Baryon No. = 0)

8798 (IPNO/LA-68/22) THREE BODY RESONANCES. Basdevant, J. L.; Omnes, R. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1968. 22p. (CONF-680809-34). Dep.

From 14th International Conference on High Energy Physics, Vienna, Austria.

It is shown that a pseudo-relativistic three-body theory derived on the basis of the Faddeev equations can be used to study three-body resonances when the decay products resonate by pairs. The main virtues of the method, besides its simplicity, consist in having three-body unitarity built in and in treating two-body resonances as such in particle + resonance scattering. The limitations of the theory are discussed, and in particular it is shown that the ω meson cannot be examined in such a framework. A mechanism is explained, which can be responsible for the existence of the A resonances as well as many others in systems like $\pi\pi\pi$, $K\pi\pi$, and $KK\pi$, above 1 GeV. This mechanism is shown to have no relations with the Peierls mechanism which cannot give rise to these resonances. It is explained that the existence of an isospin two π-ρ resonance at around 1300 MeV would be a very strong argument in favor of the theory. (auth)

8799 DOUBLE-POLE FIT TO $A_2(1300)$ MASS SPECTRA. Beaupre, J. V.; Coleman, T. P.; Lassila, K. E.; Ruuskanen, P. V. (Ames Lab., Iowa). Phys. Rev. Lett., 21: 1849-51(Dec. 30, 1968).

A double-pole explanation of the $A_2(1300)$ meson is shown to be consistent with recent bubble-chamber measurements of its missing-mass spectrum and of its $K_1^0K_1^0$-decay-mode mass spectrum. (auth)

8800 ON THE LOW-ENERGY BEHAVIOUR OF S-WAVES IN $\pi\pi$ SCATTERING. Pisut, J. (Univ., Komenskeho, Bratislava). Nucl. Phys., B8: 159-73(1968).

The inverse (Gilbert-type) dispersion relations (DR) for the forward $\pi\pi$ scattering amplitude are used to get an information on the low-energy behavior of T = 0 and T = 2 S-waves. Inverse DR contain no free parameters and are dominated by the T = J = 1 partial wave contribution. The best solution for isospin-zero S-wave has a negative scattering length $a_0 = -0.3$ and the phase shift passes through zero at about 450 MeV. The isospin-two-S-wave scattering length is positive, $a_2 = 0.2$ and the phase shift passes through zero at about the same energy as δ_0^0. Some implications of this type of the phase shifts behavior are discussed. (auth)

8801 NOVEL APPLICATION OF REGGE TRAJECTORIES. Lovelace, C. (CERN, Geneva). Phys. Lett., 28B: 264-8(Dec. 9, 1968).

It is suggested that Dalitz plots for 3π decays and annihilations are "measurements" of $\pi\pi$ scattering in the double spectral region. Veneziano's formula for crossing-symmetric Regge trajectories both justifies the external mass extrapolation and correctly predicts the experimental results. It also fulfills Adler's self-consistency condition if $\alpha_\rho(m_\pi^2) = \frac{1}{2}$. (auth)

8802 AN I = 1 $\pi\pi$ DYNAMICAL CALCULATION USING FINITE-ENERGY SUM RULES AND UNITARITY. Balazs, L. A. P. (Imperial Coll. of Science and Tech., London). Phys. Lett., 28B: 269-71(Dec. 9, 1968).

A simple calculation is presented, in which finite-energy sum rules (with both positive and negative moments) are combined with an effective-range formula satisfying unitarity. (auth)

8803 EVIDENCE FOR A PSEUDO-TENSOR MESON NONET WITH NEGATIVE C-PARITY IN THE NEIGHBORHOOD OF 1,800 MeV. Niizeki, Komajiro (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 40: 906-9(Oct. 1968).

It is assumed that ρ_A and $L(\overline{L})$ together with ϕ_A and ϕ'_A form a pseudo-tensor meson nonet with negative C-parity. The partial decay widths of these mesons are examined in order to check the multiplet assignment. Other partial decay widths of the decays $T' \to VP$ and $T' \to TP$ for the members of the multiplet are predicted. The agreement of the theoretical and the experimental partial decay widths is satisfactory. (L.B.S.)

8804 ASYMPTOTIC BEHAVIOR OF INFINITELY RISING MESON TRAJECTORIES. Ida, Masakuni (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 901-4(Oct. 1968).

The possibility that Regge trajectories $\alpha(s)$ approach infinity as $s \to +\infty$ and lead to an infinite number of Regge recurrences is considered. It is shown that under some physically plausible assumptions on the analyticity and asymptotic behavior of $\alpha(s)$, meson trajectories cannot increase faster than linearly with s. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 8748 and 9020.

8805 (INP-622(Vol.1), pp 75-84) SUPERCONVERGENCE AND FINITE ENERGY SUM RULES. Kwiecinski, Jan (Institute of Nuclear Physics, Krakow (Poland)).

The foundation and some applications of the superconvergence relations and their generalization to finite energy sum rules are discussed. The application of superconvergence relation is illustrated in the case of meson-baryon scattering within SU(3) symmetry. (L.B.S.)

8806 (INP-622(Vol.1), pp 85-104) POLARIZATION IN HIGH ENERGY MESON-NUCLEON SCATTERING. Sonderegger, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The various experimental methods used for polarization measurements are reviewed. Some relevant experiments in meson-nucleon scattering are described, and their results are interpreted qualitatively in terms of the Regge pole model. (L.B.S.)

8807 (INP-622(Vol.1), pp 105-46) K^+p PHASE SHIFT ANALYSIS AND THE POSSIBLE EXISTENCE OF A Z_1 RESONANCE. Lea, Andrew T. (Rutherford High Energy Lab., Chilton (England)).

The basic formalism for KN scattering is first reviewed and the electromagnetic corrections needed are discussed. A rather detailed study of the experimental data is given, and the results of fitting all the differential cross-section data with a Legendre polynomial series are presented. This is followed by a description of some necessary assumptions made and of the techniques employed. The results are presented and suggestions are made for future experiments. The current evidence for a Z_1^+ resonance is listed. (L.B.S.)

8808 PION-NUCLEON SCATTERING NEAR THE THRESHOLD ENERGY. Sugano, R. (Dalhousie Univ., Halifax, Nova Scotia). Nuovo Cim., 58A: 882-90(Dec. 21, 1968).

It is shown that approximately the same results for S-wave πN scattering can be obtained in the pseudoscalar-pseudoscalar coupling theory using Adler's consistency condition as those from current algebra. (L.B.S.)

8809 MESON-NUCLEON ELASTIC SCATTERING AND PHOTOMESON PRODUCTION VIA THE u CHANNEL. Paschos, Emmanuel A. (Stanford Univ., Calif.). Phys. Rev. Lett., 21: 1855-9(Dec. 30, 1968).

An explanation of the available pion-nucleon and photo-meson production data on the backward direction is proposed using baryon trajectories. Special emphasis is given to the constraints, the unequal-mass kinematics, and their implications. (auth)

8810 POLARIZATION IN THE OPTICAL MODEL FOR ANTINUCLEON-NUCLEON COLLISIONS. Turovskii, M. I. Yadern. Fiz., 8: 738-40(Oct. 1968). (In Russian).

To calculate polarization which appears in nucleon-antinucleon collisions, a potential is used which reasonably interprets the behavior of cross sections of various processes. (auth)

8811 PION-NUCLEON SCATTERING AND PRODUCTION IN THE D_{13} STATE. Lomon, E. L.; Miller, A. I. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett., 21: 1773-6(Dec. 23, 1968).

A coupled-channel $\rho N - \pi N - \pi\Delta$ system is shown to be a good representation of the πN D_{13} amplitude below 700 MeV. It predicts the important features of the $\pi\pi N$ final states in the same energy range. Effects of other channels are discussed. (auth)

8812 REGGE-POLE MODEL WITH CUTS GENERATED BY ABSORPTION FOR THE REACTION $\pi^+n \to \omega p$. Henyey, F. (Univ. of Michigan, Ann Arbor); Kajantie, K.; Kane, G. L. Phys. Rev. Lett., 21: 1782-5(Dec. 23, 1968).

The reaction $\pi^+n \to \omega p$ is analyzed in terms of a model based on the exchange of the ρ Regge pole and the associated cuts generated by absorption. The data, in particular the absence of a dip in the differential cross section and the large positive values of the density matrix element ρ_{00}, can be well described by this model only if the amplitudes do not vanish at nonsense, wrong-signature points. (auth)

8813 ASYMPTOTIC BEHAVIOR OF INFINITELY RISING BARYON TRAJECTORIES. Ida, Masakuni (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 904-6(Oct. 1968).

The asymptotic behavior of infinitely rising baryon trajectories $\alpha(\omega)$ is studied. Under certain assumptions it is shown that $\alpha(\omega)$ should increase more rapidly than $|\omega|^{n-1+\epsilon}$ but less rapidly than $|\omega|^n$, where n = 2,6,10,.... (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 8731, 8779, and 8849.

8814 (JINR-P2-4176) THREE-PARTICLE INTERACTIONS AT HIGH ENERGIES. Artykov, I. Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 9p. (In Russian). Dep.

The energy dependence of the many-particle interaction probability is studied by the example of inelastic interactions of three nucleons. This dependence if defined, in general, by the total energy in the cms and, at fixed energy, changes weakly with the energy change of one of the colliding particles. (auth)

8815 ON THE WELL DEPTH OF Λ IN NUCLEAR MATTER. Bhaduri, R. K. (McMaster Univ., Hamilton, Ont.); Nogami, Y.; Friesen, P. H.; Tomusiak, E. L. Phys. Rev. Lett., 21: 1828-31 (Dec. 30, 1968).

In the presence of strong ANN forces, the average potential in which a Λ moves is no longer of Woods-Saxon shape. This invalidates the current procedure of estimating the well depth of Λ in nuclear matter. This is indicated by the present calculation with the two-pion-exchange ANN potential. (auth)

8816 REGGE BEHAVIOR AT LARGE ANGLES, AND THE DOLEN-HORN-SCHMID DUALITY IN ELASTIC PROTON-PROTON

SCATTERING. Pinsky, S. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 21: 1776-8(Dec. 23, 1968).

Elastic proton-proton scattering is studied at high energies. It is shown that at large angles the data are fitted by $d\nu/d\Omega = s^{-1}K(t)(\nu/s_0)^{2\alpha(t)}$, where $\nu = \frac{1}{2}(s-u)$, which indicates that Regge theory is good at all angles at high energy. It is also shown how to avoid double counting parallelling Dolen, Horn, and Schmid. (auth)

8817 N–N* INTERACTIONS WITH FADDEEV EQUATIONS. Gale, William A.; Duck, Ian M. (Rice Univ., Houston, Tex.). Nucl. Phys., B8: 109-30(1968).

The problem of whether a two-nucleon bound state or resonance can arise dynamically from the Peierls mechanism–the exchange of a real pion by two nucleons having a resonant interaction with the pion is discussed. A number of low partial waves of the nucleon-pion system are examined to determine in which states the resonant pion exchange mechanism gives rise to significant attractive forces with the possibility of creating a bound state or resonance. The principal tool is the non-relativistic Faddeev equation incorporating isospin and spin. A relativistic extension of the Faddeev equations due to Lovelace is also used. The pion-nucleon interaction is represented by a separable potential, but the sensitivity of the results to the exact form of this interaction is investigated. The principal result for the NNπ system is that there will be no bound states but two broad resonances with isospin two indicated at an energy about 350 MeV above the nucleon-nucleon threshold. Spinless bosons of the nucleon-mass would have a bound state in a non-relativistic model. (auth)

8818 FERMI MOTION IN PION DEUTERON SCATTERING AT HIGH ENERGIES. Faeldt, Goeran; Ericson, T. E. O. (CERN, Geneva). Nucl. Phys., B8: 1-8(1968).

The Fermi motion plays an important role in resonant multiple scattering. Its conclusion restores the agreement between experiments and Glauber theory. (auth)

8819 SOLUBLE MODEL OF A COUPLED MESON–NUCLEON SYSTEM. Dover, Carl B. (Univ., Heidelberg). Ann. Phys. (N.Y.), 50: 449-71(1968).

An exactly soluble model, in which fermions in a many-body system interact through the exchange of a massive boson, is investigated, The model deals with the linear coupling of a neutral scalar meson field to fermion density fluctuations. These density fluctuations, or particle-hole excitations, are treated within the framework of the random phase approximation (RPA), while the meson degrees of freedom are treated exactly. Within the RPA, coupled oscillator equations of motion are obtained, which are subjected to a normal mode analysis. A dispersion relation for the normal mode energies is obtained, and the operators which create the properly "dressed" particle-hole and meson modes are constructed. The density-density correlation function and the meson Green's function are calculated exactly. The structure of the Green's functions is also explored from the point of view of their coupled equations of motion, which can be decoupled and solved in the RPA model. The exact interaction energy, the scattering matrix for particle-hole pairs, and the number of mesons produced by the interaction are also calculated. (auth)

8820 TWO-PION EXCHANGE CONTRIBUTION TO THE DEUTERON–NUCLEON FORM FACTOR. Bebel, D.; Biebl, K.-J. (Humboldt Univ., Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 10: 538-45(1968). (In German).

The results of an investigation of the effect of the second abnormal branching cut on the form factor are reported. This cut represents two-pion exchange effect and belongs to a series of iterative cuts, which represent the relativistic analogs to the higher Born approximations in the potential theory. The numerical results for the imaginary part of the four relativistic form factor variants in the abnormal range are given graphically. (J.S.R.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 8759.

8821 (IC–68/92) SIMPLY TRANSITIVE SUBGROUPS G_4 OF THE POINCARE GROUP: A NEW FINDING IN THE SPECIAL THEORY OF RELATIVITY. Schremp, E. J. (International Centre for Theoretical Physics, Trieste (Italy)). Sept. 1968. 33p. Dep.

A new finding in the special theory of relativity is presented which is believed to be significant, partly because it firmly reestablishes the pre-relativity concept of absolute simultaneity on a new Lorentz invariant basis, and partly because it appears to provide a possible new pathway to a deeper conceptual framework of description for elementary particle theory, in terms of new geometrical concepts of internal structure relating to space-time. The finding is summarized in the following theorem: Corresponding to every proper orthochronous Lorentz matrix L, there exists a distinct 1-parameter family of simply transitive non-Abelian 4-parameter subgroups G_4 of the Poincare group G_{10}, each G_4 being specifiable in terms of the characteristic values and characteristic vectors of L. This theorem is proved, and some of its more immediate applications are examined. (L.B.S.)

8822 (NP–17687) REGULAR REPRESENTATION OF THE GROUP SU(3): EIGENFUNCTIONS AND EIGENVALUES OF THE BELTRAMI–LAPLACE OPERATOR DEFINED ON THE 4-DIMENSIONAL MANIFOLD IN THE EUCLIDEAN SPACE R_8. Note No. 181. Liotta, R. S.; Triolo, L. (Rome Univ. (Italy). Istituto di Fisica). July 22, 1968. 6p. Dep.

The subspace of R_8 (octet space) invariant under the transformations of the regular representation of SU(3) is defined. The Beltrami–Laplace operator in this subspace is given and the properties of its eigenfunctions are found. (L.B.S.)

8823 GENERALIZED SYMMETRIES AND DEFORMATIONS OF THE DIRECT SUMS OF LIE ALGEBRAS. Lyakhovskii, V. D. (Leningrad State Univ.). Commun. Math. Phys., 11: 131-7(1968).

The problem of the combined space-time and internal symmetry of elementary particles is investigated from the view-point of the Lie algebras deformation theory. It is demonstrated that the deformations of the direct sum of the Poincaré and internal symmetry algebras conserve the structure of the direct sum, if the internal symmetry is semi-simple or is described by the special type of algebras with abelian ideal. So the internal and space-time characteristics of the system remain independent. (auth)

8824 ON GELL-MANN'S λ-MATRICES, d- AND f-TENSORS, OCTETS, AND PARAMETRIZATIONS OF SU(3). Macfarlane, A. J.; Sudbery, A.; Weisz, P. H. (Univ. of Cambridge, Eng.). Commun. Math. Phys., 11: 77-90(Nov. 11, 1968).

The algebra of SU(3) is developed on the basis of the matrices λ_i of Gell-Mann, and identities involving the tensors d_{ijk} and f_{ijk} occurring in their multiplication law are derived. Octets and the tensor analysis of the adjoint group SU(3)/Z(3) of SU(3) are discussed. Various explicit parametrizations of SU(3) are presented as generalizations of familiar SU(2) results. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 8725.

8825 JINR–P2-4129) VIOLATION OF THE CP-INVARIANCE IN K-MESON DECAYS. Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 25p. (In Russian). Dep.

The problems of the CP-invariance violation in the decays of neutral K-mesons are reviewed. Phenomenological questions are mainly discussed. Effective equation for the system, described by superposition of K^0 and $\overline{K}^0$ states, is discussed. The $K_L \to 2\pi$ decays and the lepton decay of K_L-mesons are considered as well as the model of superweak interaction. (auth)

8826 (UR–875-259) A MODEL OF MAXIMAL CP VIOLATION. Okubo, S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Oct. 3, 1968. Contract AT(30-1)-875. 16p. (CONF-680927-2). Dep. CFSTI.

From Conference on Hadron Spectroscopy, Keszthely, Hungary.

A model of maximally CP-violating Hamiltonian for weak interactions is formulated. It is assumed that weak intermediate vector mesons exist and are members of a unitary nonet or octet of Yang–Mills type. Also, the weak interaction Hamiltonian has CP = 1. It is shown that the first order effect in the semi-weak coupling constant g withoug any real W-meson emission or absorption is zero due to the conservation of Q_w and Y_w quantum numbers of W-mesons. (L.B.S.)

8827 A MODEL FOR WEAK CURRENTS AND RESULTING WEINBERG'S SUM RULES. Burnel, A.; Caprasse, H. (Univ., Liege). Nucl. Phys., B8: 65-72(1968).

A quantized non-conserved four-component field theory is constructed in view to identify the axial currents with fields of this kind. The identification of non-strange vector and axial vector currents is done with the usual ρ and A_1 fields, while the strangeness carrying currents are assumed to be dominated by two vector particles. A new sum rule relating the K decay amplitude to the decay amplitudes (assumed to be the same) and the masses of the two strange axial vector particles is derived. The ratios F_K/F_π

and F_{K^*}/F_ρ are deduced and their values are found to be in good agreement with experiment. The second Weinberg sum rule for SU(2) ⊗ (SU(2) is seen to be valid for non-strange isomultiplets and violated by an amount of about 15% for the strange ones. (auth)

8828 PHENOMENOLOGICAL DESCRIPTION OF $K_S \to 2\gamma$ AND $K_L \to 2\gamma$ DECAYS. Martin, B. R.; de Rafael, E. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., B8: 131-49 (1968).

A phenomenological description of $K_S \to 2\gamma$ and $K_L \to 2\gamma$ decays is presented in the context of CP non-conservation. Estimates of some of the parameters describing these processes are made using mainly CPT invariance and unitarity. A discussion is given of possible measurements which have bearing on the question of CP non-invariance. The most promising type of experiment appears to be the measurement of the time dependence of the asymmetry of intensities between $K^0 \to 2\gamma$ and $\bar{K}^0 \to 2\gamma$ decays. Numerical results are presented for the latter case corresponding to various choices of parameters. (auth)

8829 BROKEN CHIRAL U(3) ⊗ U(3) MODEL FOR NON-LEPTONIC DECAYS. Sakuraoka, Mitsuru; Toda, Azuma (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 40: 909-11(Oct. 1968).

The nonleptonic decays of K mesons and hyperons are studied in terms of the phenomenological Lagrangian method, based on the transformation properties of the pseudoscalar meson and baryon system under chiral U(3) ⊗ U(3). The amplitudes for the $K \to 3\pi$ and $K \to 2\pi$ decays are predicted and compared with experimental results. The model yields similar results for the nonleptonic s-wave decays of hyperons. (L.B.S.)

8830 SUPERWEAK INTERACTION OF NEUTRAL CURRENTS. Tsai, S. Y. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 40: 914-16(Oct. 1968).

A different approach to the superweak interaction is presented, which admits the possibility of unitary-spin currents belonging to the U-spin triplet. A neutral current x current interaction is constructed by analogy with the usual weak interaction. The possibility that this interaction may or may not violate CP is considered. (L.B.S.)

Applications (Strong)

8831 (ITF-68-19) QUASI-RELATIVISTIC SCHROEDINGER EQUATION FOR BARYONS AND $SU(6)_W$ SYMMETRY. Kobushkin, A. P.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 13p. (In Russian). Dep.

The problem of quasi-relativistic generalization of the Schrödinger equation for Dirac particles and bosons is considered in the framework of composite model in external magnetic field. It is shown that the ordinary quark spin must be replaced by W-spin in order that the equation obtained by consistent with the initial one. It means from the point of view of internal symmetry group that the nonrelativistic group SU(6) is replaced by quasirelativistic $SU(6)_W$. (auth)

8832 CHIRAL DYNAMICS, SU(3) x SU(3) FIELD ALGEBRA AND SYMMETRY BREAKING. Mitter, P. K.; Swank, L. J. (Univ. of Maryland, College Park). Nucl. Phys., B8: 205-15(1968).

Chiral field algebra Lagrangians are constructed in SU(3) × SU(3) consistent with the assumption that chiral symmetry breaking transforms as the (3,3*) ⊕ (3*,3) representation of SU(3) × SU(3). Alternative models are constructed based on stated assumptions and consequences are obtained for two point functions (in the K* and ρ directions). The magnitude of symmetry breaking is related to the status of $K_A(1^+)$ and $\kappa(0^+)$ mesons. The techniques are useful for the study of (3,3*) ⊕ (3*,3) symmetry breaking in higher point functions within the framework of chiral dynamics. (auth)

8833 THE SU(3) STRUCTURE OF NEGATIVE-PARITY BARYON STATES. Pakvasa, S.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Nucl. Phys., B8: 95-108(1968).

It is argued that our present knowledge of the negative-parity baryon mass spectrum is consistent with the simplest possible assumptions concerning their SU(3) structure. Some relatively exact statements can therefore be made concerning the masses which are amenable to immediate experimental tests. The more complex questions of decay, decay sum rules, and mixing, are then examined in the general framework of the simplified assumptions. (auth)

8834 DESCRIPTION OF THE SYMMETRY GROUP SU3/Z3 OF THE OCTET MODEL. Macfarlane, A. J. (Cambridge Univ., Eng.). Commun. Math. Phys., 11: 91-8(1968).

A study is made of the relationship of SU(3) and its adjoint group SU(3)Z(3) to the subgroup of R8 which leaves invariant not only the length $a_i a_i$ of a real eight component vector a_i but also the cubic invariant $d_{ijk}a_i a_j a_k$, d_{ijk} being the totally symmetric isotropic SU(3) tensor introduced by Gell-Mann. A formula for the rotation R∈ R(8) corresponding to U∈ SU(3), and a formula inverse to this, which provides a way of parametrizing U∈ SU(3), are derived. (auth)

8835 THE HOMOGENEOUS LORENTZ GROUP AND THE REACTION $\pi^- p \to \eta n$ AT LARGE MOMENTUM TRANSFER. George, David J.; Nath, L. M. (Purdue Univ., Lafayette, Ind.). Progr. Theor. Phys. (Kyoto), 40: 895-6(Oct. 1968).

It is shown that the homogeneous Lorentz group calculation of the differential cross section for the process $\pi^- p \to \eta n$ reproduces experimental results at 10 GeV/c very well. In particular it explains the slight shoulder at $t \approx -1(\text{GeV/c})^2$ in a way which depends on the O(3.1) structure and not on fitted parameters. (L.B.S.)

Field Theories

General

Refer to abstract 8759.

Quantum Field Theory

Refer also to abstracts 9015 and 9016.

8836 (EUR-4048) INTERACTING KNOTS IN GEOMETRODYNAMICS. Mueller, K.-H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 21, 1968. 22p. Dep.

Physics can be interpreted as the totality of all physically perceptible aspects of the fluctuating space-age continuum. This geometrization leads, among other facts, to discrete stable and normalizable solutions called space-time knots. Such knots transport perturbation and interact with another. Kinematics and dynamics of systems of a sufficient high knot density are governed by a transport equation. (auth)

8837 (JINR-E2-4149) FIELD OPERATOR FOR INTERACTING UNSTABLE ELEMENTARY SYSTEM. Lukierski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 9p. Dep.

The field operator $\phi^{(x_\mu s)}_{j,d}$, describing interacting unstable elementary system is introduced. Asymptotic fields are represented by free fields with continuous additional parameter. There is achieved the consistency with Haag-Ruelle theory of asymptotic states. (auth)

8838 COVARIANT HAMILTONIAN FORMALISM FOR PARTICLES OF ANY SPIN AND NONZERO MASS. Enatsu, H. (Ritsumeikan Univ., Kyoto). Nuovo Cim., 58A: 891-7(Dec. 21, 1968).

A covariant Hamiltonian formalism is developed for free particles with any spin and nonzero mass. The Hamiltonian employed is the operator representing the square of mass. The temporal order of events is described in terms of an invariant time common to all particles and antiparticles involved. For particles of any spin, canonical commutation relations are shown to have manifestly covariant forms, involving merely the four-dimensional Dirac's δ-function. The theory provides a generalization of the Heisenberg–Pauli theory to particles of any spin, and, at the same time, a simplified counterpart of the Fiery theory for arbitrary spin. (L.B.S.)

8839 SINGULAR EQUAL-TIME BEHAVIOUR OF CURRENT COMMUTATORS IN PERTURBATION THEORY. Kaschluhn, F.; Wieczorek, E.; Zoellner, W. (Humboldt Univ., Berlin. Forschungsstelle fuer Physik hoher Energien, Berlin). Nucl. Phys., B8: 84-94(1968).

The singular equal-time behaviour of the vacuum expectation value of current commutators is determined for a field-theory model in second-order perturbation theory. Using the well-known properties of the Wightman functions involved and relations for generalized functions studied in detail by Gelfand and Shilov it is shown in an unambiguous way that a gradient term appears whose coefficient has the singular behaviour P/z_0^4 and $\log|z_0|$ with respect to the relative time (the first term is also found in second-order quantum electrodynamics). The relation to the T product of currents is investigated and defined within a special class of test functions. Furthermore, it is shown that the divergence of the T-product of conserved vector currents is localized in the sense of quasi-local operators involving arbitrary renormalization constants. (auth)

8840 RELATIVISTIC WAVE EQUATIONS IN A FIVE-DIMENSIONAL APPROACH. Ten Kate, A. (Univ. of Nijmegen, Netherlands). Nucl. Phys., B8: 73-83(1968).

In a recently proposed five-dimensional formalism a set of relativistic wave equations can be written down for each finite-dimensional representation of the De Sitter group. These representations can be labeled by two numbers (μ_1,μ_2), both integer or halfinteger, satisfying $\mu_1 \geq \mu_2 \geq 0$. The corresponding relativistic wave equations describe massive particles of spin μ_2. The equations for the most general case (μ_1,μ_2) are written explicitly. All equations, obtained in this way, turn out to be closely related to the Bargmann-Wigner equations. (auth)

8841 INTERNAL CHARGE OF THE GAUGE FIELD. Uzes, C. A. (Univ. of Georgia, Athens). Ann. Phys. (N.Y.), 50: 534-47(1968).

The internal charges of the non-Abelian gage field are investigated on the classical level. Restrictions which insure that the definition of the internal charges is geometrically meaningful and relativistically invariant are employed to determine their physical nature. The possibility for the geometric breaking of the global conservation laws of the covariant divergence free currents is shown not to exist; their charges if defined and comparable at in and out states are also conserved. It is found that for localized external sources and gage fields only one of the currents, the Yang–Mills current, leads to a nonvanishing total charge. A gage-invariant definition is given for the internal charge carried by the gage field itself. It is shown that the components of the gage field giving rise to the internal charge satisfy Maxwell's equations either everywhere or at large distances from the source region. This indicates that the gage field can account only for electric charge. (auth)

8842 POSITION-SPACE ANALYTIC FUNCTIONS DUAL TO THE FEYNMAN INTEGRALS AND THEIR MASS-SUPERPOSITIONS. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 40: 864-92(Oct. 1968).

A perturbational integral in position space, which is dual to the Feynman integral in momentum space, is introduced and the analytic properties of a superposition of the integral with respect to the variables corresponding to the masses squared are studied. The superposed function is presumed to be a working representation of the Wightman function satisfying the local commutativity condition. (auth)

8843 INVALIDITY OF TCP-THEOREM FOR INFINITE-COMPONENT FIELDS. Oksak, A. I.; Todorov, I. T. (Joint Inst. for Nuclear Research, Moscow). Commun. Math. Phys., 11: 125-30(1968).

Necessary conditions are given for the TCP invariance of a local field with usual energy-momentum spectrum. Examples are constructed of both Fermi and Bose local free infinite-component fields which violate these conditions and consequently do not allow a TCP symmetry. (auth)

8844 NOTE ON ANOTHER EXPANSION PARAMETER IN QUANTUM ELECTRODYNAMICS. Terazawa, Hidezumi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 830-3(Oct. 1968).

An effective expansion parameter in quantum electrodynamics, $\beta \equiv 2\alpha/3\pi \ln(m_\mu/m_e)$, is proposed and the convergence of a power series in β is discussed for the anomalous magnetic moment of the muon. The series is shown to be expressed as $\mu\ (\equiv (g_\mu - 2)/2) = \alpha/2\pi \sum_{n=0}^{\infty} \beta^n \times (1 + O(\alpha/\pi))$. Under the unphysical condition, $\ln(m_\mu/m_e) \gg 1$ and $|\beta| < 1$, the leading series can be summed up into the form: $\bar{\mu} = \alpha/2\pi(1-\beta)^{-1}$. (auth)

8845 YUKAWA INTERACTION IN INFINITE VOLUME. Glimm, James (Massachusetts Inst. of Tech., Cambridge); Jaffe, Arthur. Commun. Math. Phys., 11: 9-18(Nov. 11, 1968).

The existence of the Heisenberg picture field operators for quantum fields with a Yukawa interaction is proved. The interaction density $g:\Psi^+(x)\Psi(x)\Phi(x):$ has a momentum cutoff on the fermions, but no spatial form factor, and is thus translation invariant. (auth)

8846 INTEGRAL REPRESENTATION OF POSITIVE-DEFINITE FUNCTIONALS OF WIGHTMAN TYPE. Berezanskii, Yu. M. Ukr. Math. J. (Engl. Transl.), 19: 75-80(Jan.-Feb. 1967).

Translated from Ukr. Mat. Zh., 19: 89-95(Jan.-Feb. 1967).

An integral representation of positive-definite matrices which are close to the Wightman functionals of quantum field theory is presented. The matrices considered satisfy only some of the axioms of field theory; the discussion centers mainly on the axiom of local commutativity. (auth)

Gravitation and General Relativity

8847 (CEA-R-3563) REMARKS ON THE MOTION OF MACROSCOPIC AND MICROSCOPIC SPINNING PARTICLES IN RELATIVITY. Micoulaut, Raymond (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Sept. 1968. 27p. (In French). Dep.

The Papapetrou equations of motion of a spinning particle do not allow the univoque determination of the worldline described by the particle. The motion should be completely determined in adding a supplementary condition. For macroscopic particles, characterized by the conditions of Corinaldesi-Papapetrou and Tulczyjew, moving in a Schwarzschild field an additional term in the expression for the advance of perihelion is obtained. For microscopic particles the results obtained using the conditions of Weyssenhoff, Nakano, Hönl-Papapetrou and Wessel are summarized. (auth)

8848 VARIATIONAL METHODS AND POSITIVE ENERGY IN GENERAL RELATIVITY. Brill, Dieter R. (Yale Univ., New Haven); Deser, Stanley. Ann. Phys. (N.Y.), 50: 548-70 (1968).

The problem of positive-definiteness of the field energy in general relativity is analyzed and resolved by means of a variational procedure. It is shown that, among all asymptotically flat solutions of the source-free Einstein equations, only flat space extremizes the energy. That the energy is nonnegative is then established by showing that its second variation (i.e., the weak field energy) about this "point" is positive. As a corollary, any solution for which this one number–the total energy–vanishes is everywhere flat. Hence, as in other field theories, the vacuum is the lowest energy state. When usual matter sources (with positive-definite flat-space energy) are minimally coupled to gravitation, the total energy is still positive and the lowest energy state of the interacting system is again the (combined) vacuum. (auth)

Scattering Theory

8849 (CALT-68-174) ANALYTICITY, FACTORIZATION, AND LORENTZ SYMMETRY. di Vecchia, P. (California Inst. of Tech., Pasadena. Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Drago, F. (California Inst. of Tech., Pasadena). Sept. 1968. Contract AT(11-1)-68. 20p. (CONF-680927-3). Dep. CFSTI.

From Conference on Hadron Spectroscopy, Neszthely, Hungary.

The scattering amplitude at t = 0 is reconstructed for the process N + N → N + N due to the exchange of a Regge pole family with a defined value of the Toller quantum number M. The complete equivalence is shown between the group-theoretical and the analytical approach at t = 0 in the equal mass configuration. (L.B.S.)

8850 (INP-622(Vol.1), pp 1-7) RADICAL REMOVAL OF THE CONVERGENCE DIFFICULTIES. Rayski, Jerzy (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

A method is presented for computing scattering amplitudes which avoids the usual convergence difficulties. A partial process represented by a connected graph in momentum representation is called a primitive process or channel. The process is first analyzed into primitive channels; conditioned probability amplitudes are then computed for each channel separately using for each a suitable parameter P_ν. The parameters P_ν are later identified with eigenvalues of energy-momentum. (L.B.S.)

8851 (INP-622(Vol.1), pp 8-27) STRUCTURE OF THE SCATTERING AMPLITUDES FOR HIGH ENERGY COLLISIONS. Salin, Philippe (European Organization for Nuclear Research, Geneva (Switzerland)).

Some difficulties encountered by the Regge pole model for high energy scattering are discussed. The first problem discussed is related to kinematic singularities in transversity amplitudes, cross sections, and density matrix elements. The problem of constraints is then considered. It is shown that these technical complications may be avoided through the use of s-channel helicity amplitudes. (L.B.S.)

8852 (LPTHE-TH-68/34) A DERIVATION OF THE HIGH-ENERGY UPPER BOUNDS OF RELATIVISTIC AMPLITUDES AT FIXED ANGLES ($\neq 0,\pi$). Chadan, K. (Paris Univ., Orsay (France)). Laboratoire de Physique Theorique et Hautes Energies). Oct. 1968. 12p. Dep.

A derivation of the high-energy fixed-angle upper bound of relativistic elastic scattering amplitudes of two scalar neutral particles of equal mass is presented. (W.H.K.)

8853 TRAJECTORIES IN VENEZIANO'S MODEL. Roskies, Ralph Z. (Yale Univ., New Haven). Phys. Rev. Lett., 21: 1851-4(Dec. 30, 1968). (YALE-2726-538).

The trajectories in Veneziano's amplitude which give rise to true Regge behavior (without the oscillations inherent in amplitudes with very narrow resonances) are studied. It is found that

the asymptotic form of the imaginary part of the trajectory is strongly constrained, but an example of a trajectory having the requisite properties is given. (auth)

8854 DIFFRACTION DISSOCIATION AND THE REGGEIZED ABSORPTION MODEL. Ravenhall, D. G.; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 21: 1770-2(Dec. 23, 1968).

A simplified but self-consistent model calculation is made to include the effects of diffraction dissociation in the Reggeized absorption model of Henyey et al. The calculation provides a method for estimating their parameter λ, which describes the extra effect of diffractive dissociation. An estimate based on present experimental information is not as large as the value they need to fit the data. (auth)

8855 MULTIPLE POLES IN THE SCATTERING GREEN'S FUNCTION AND THE LIGHTLIKE LIMIT OF THE BETHE–SALPETER AMPLITUDE. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1585-97(June 1968).

It is investigated how the Bethe–Salpeter amplitudes behave, when the bound-state four-momentum tends to a lightlike vector, in the ladder model in which two scalar particles exchange scalar particles having mass μ. For $\mu \neq 0$, it is inferred that the scattering Green's function has multiple poles at $s = 0$, where s stands for the invariant total energy squared, by proving that certain Bethe–Salpeter amplitudes are missing at $s = 0$ in the equal-mass case. Some evidences of the existence of multiple poles are pointed out also in the unequal-mass case with $\mu \neq 0$. (auth)

8856 GENERALIZATION OF VENEZIANO'S FORMULA FOR THE FIVE-POINT FUNCTION. Virasoro, M. A. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 22: 37-9(Jan. 6, 1969).

Veneziano's formula for the five-point function was generalized by writing an integral formula on a two-dimensional space and imposing on it the requirements implied by crossing symmetry, analyticity, and Regge behavior. (auth)

8857 REGGE CUTS AND FINITE ENERGY SUM RULES. Rivers, R. J. (Univ. of Chicago). Phys. Rev. Lett., 22: 85-8 (Jan. 13, 1969).

Including Regge-cut amplitudes in finite-energy sum rules for inelastic scattering the possibilities are examined that either they are built up by part of the direct-channel resonance contributions, in which case they can significantly alter some of the bootstrap predictions, or they are built up by a nonresonant background, in which case mesons with $Y = 2$ are required that couple to the KK system. (auth)

8858 QUANTIZATION CONDITIONS FOR REGGE INTERCEPTS AND HADRON MASSES. Ademollo, M. (Harvard Univ., Cambridge, Mass.); Veneziano, G.; Weinberg, S. Contracts AT(30-1)-2098; Nonr-1866(55); 49(638)-1380. Phys. Rev. Lett., 22: 83-5(Jan. 13, 1969).

It is shown that a reasonable generalization of the beta-function formula to the reaction $\pi + A \rightarrow B + C$ combined with Adler's self-consistency condition, implies that trajectories of opposite normality that can be connected by pion emission must have the same slope, and that their intercepts must differ by a half-odd integer. The agreement with experiment seems very good. (auth)

8859 NEW EXAMPLE OF A CROSSING SYMMETRIC REGGE BEHAVED AMPLITUDE. Jengo, R. (CERN, Geneva). Phys. Lett., 28B: 261-3(Dec. 9, 1968).

An example is shown of a Regge behaved, crossing symmetric amplitude, with linearly rising trajectories, such that it has the right branch points in s and t, and the residue of a pole, say in t, is a polynomial in s. The example does not show duality, it is rather like a sum of direct and crossed channel resonances. (auth)

8860 THE N-BODY PROBLEM WITH SPIN–ORBIT OR COULOMB INTERACTIONS. van Winter, Clasine; Brascamp, H. J. (Univ. of Kentucky, Lexington. Univ., Groningen, Netherlands). Commun. Math. Phys., 11: 19-55(Nov. 11, 1968).

A study is made of the resolvent $R(\lambda)$ for a system of n particles with spin-orbit coupling, an interaction which necessarily has a long range in momentum space. For short-range interactions, it has been known for several years that $R(\lambda)$ satisfies a Fredholm equation whose kernel is in the Schmidt-class. The corresponding spin-orbit kernel is not in the Schmidt-class, but it is shown that it does belong to a certain class of compact operators which is larger than the Schmidt-class. A modified Fredholm theory is presented which applies to all operators in this larger class. This enables $R(\lambda)$ to be found for all values of λ in the complex plane cut along the continuous spectrum of the Hamiltonian. It is shown that the modified Fredholm theory also holds for the Coulomb interaction. (auth)

8861 DETERMINATION OF THE HIGH-ENERGY ASYMPTOTIC PROPERTIES POSSESSED BY THE SCATTERING AMPLITUDES OF QUANTUM-MECHANICAL PARTICLES SCATTERED BY ENERGY-DEPENDENT POTENTIALS. Mal'chenko, V. I. Ukr. Math. J. (Engl. Transl.), 19: 88-92(Jan.-Feb. 1967).
Translated from Ukr. Mat. Zh., 19: 102-8(Jan.-Feb. 1967).

A number of studies of the possible ways of constructing spectral representations for the scattering amplitudes of elementary particles scattered by energy-dependent potentials have been presented. These researches are continued, and the asymptotic properties of the quantum-mechanical scattering amplitudes at large values of the energy variable are established. (auth)

8862 REGGE INEQUALITY IN THE S-MATRIX THEORY. Arai, Masahiko; Hayashi, Koichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 916-17(Oct. 1968).

The Regge inequality on the derivative of the phase shift with respect to angular momentum is proved in the S-matrix theory. (L.B.S.)

Particle Accelerators

Refer also to abstracts 7795, 8703, and 8759.

8863 (AECL–3160) FOCAL LENGTHS AND PRINCIPAL-PLANE POSITIONS OF QUADRUPOLE DOUBLET AND TRIPLET LENSES. Bezic, N.; Malecki, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1968. 57p. (FSD/ING–138). Dep. CFSTI. CAN $1.50.

The report consists of a collection of graphs showing the variation with lens strength of the focal lengths and the positions of the principal planes for doublet and symmetric-triplet quadrupole lenses. On each sheet curves of one of the quantities studied have been plotted against the strength of the first lens component for a number of values of the strength of the second lens component. Curves for different ratios of component lengths and spacings appear on different sheets. (auth) (AECL)

8864 (CEA-R–3277) PERTURBATION ANALYSIS OF CYCLOTRON RESONANCE IN THE ELECTROMAGNETIC FIELD OF A TE_{011} MODE. Dreicer, Harry (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1968. 19p. (In French). Dep.

The motion of an electron orbiting under the combined action of a static magnetic field and the ac azimuthal electric field of a cylindrical TE_{011} mode is analyzed with help of a perturbation technique. The first and second order perturbation results indicate that at cyclotron resonance the electron's center of gyration oscillates slowly at right angles to the magnetic field between two turning points. It is found that superimposed upon this nearly static Exb drift the electron cyclically undergoes the process of cyclotron absorption and induced emission. Results indicate that it is possible to insure maser action (i.e., induced emission rather than absorption) without special preparation of the electron's velocity provided that the electron is introduced into the field in certain special regions of space pervaded by the TE mode. This is a case where over-population of the upper state is accomplished through pumping in real space. The relation between an electron cyclotron resonance maser based upon this principle and one based upon the principle of velocity space pumping, due to Twiss, is examined. This treatment provides physical interpretations and verifies the numerical results found earlier by Le Gardeur. (auth)

8865 (JINR-P9-4132) PROBLEMS OF PARTICLE MOTION IN ADGESATOR. Ivanov, I. N.; Iovnovich, M. L.; Kuznetsov, A. B.; Obukhov, Yu. L.; Reshetnikova, K. A.; Rubin, N. B.; Sarantsev, V. P.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 24p. (In Russian). Dep.

A system, designed for production of charged bunch, is one of the components of collective ion acceleration. Self-consistent motion of particles in such a system, called adgesator, is considered. Necessary parameters of the ring bunch and its motion are calculated. (auth)

8866 (NP-tr–1714) EXPERIMENTS WITH SYNCHROTRON RADIATION. Haensel, R.; Kunz, C. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Angew. Phys., 23: 276-95(1967). 53p.

A brief historical introduction is followed by an outline of the basic theory of synchrotron radiation; analytical formulas for the power distribution are given. A comparison is drawn between synchrotron radiation and radiation from other sources. The experimental tests of the theory are summarized. Several instrumental problems are outlined which are peculiar to experimenting with synchrotron radiation in the far ultraviolet. Special attention is paid to solid-state problems in a summary of those experiments in which the synchrotron is employed as a radiation source. (auth)

8867 (NP-tr-1718) CALCULATIONS OF THE ION MOTION IN THE CENTRAL REGION OF A CYCLOTRON WITH AZIMUTHAL DISPLACEMENT OF THE SOURCE. Kozlov, S. I.; Oganesyan, R. Ts.; Gi, Pek Den; Shelaev, I. A. Translated by E. W. Kendall (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P-2854. 14p. Dep. CFSTI.

The influence of azimuthal displacement of the ion source on the acceleration process in 150 and 300 cm cyclotrons is studied. It is shown that lengthening of the first half-revolution by 20° decreases the spread in orbit centers and, hence, the spread in energy, which allows one to make the extraction more effective. The position of the ion source with respect to the magnetic center of the accelerator and the electrode geometry of the central region are determined. (auth)

8868 (ORNL-4336) SHIELDING CALCULATIONS FOR A 200-MeV PROTON ACCELERATOR. Alsmiller, R. G. Jr.; Barish, J.; Boughner, R. T.; Engle, W. W. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

The results of high-energy neutron transport calculations carried out to aid in the design of the radiation shield for a 200-MeV proton accelerator are presented. (auth)

8869 (ORNL-tr-2022) EFFECTIVENESS OF BORON IN ACCELERATOR SHIELDS ON SCATTERED RADIATION. Zaitsev, L. N.; Kimel', L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by K. S. Warren, George Moore, and Martha Gerrard (Oak Ridge National Lab., Tenn.), from report JINR-P16-3936. 5p. Dep. CFSTI.

Data are presented from experimental studies on the addition of boron to ordinary concrete for two cases: (1) use of a boron-containing covering with different boron contents on the shield face and (2) addition of boron, 15 kg/m^3, to the shield. (B.G.D.)

8870 (ORNL-tr-2030) ATTENUATION OF SCATTERED RADIATION FROM A SYNCHROCYCLOTRON IN THE SHIELD. Zaitsev, L. N.; Kimel, L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A.; Cherevatenko, E. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Martha Gerrard, Kenneth S. Warren, and George E. Moore (Oak Ridge National Lab., Tenn.), from report JINR-P9-3435. 7p. Dep. CFSTI.

Calculated and measured data on neutron attenuation in hematite and ordinary concrete shielding are presented. The neutron flux was measured in concrete blocks located in the yoke of the OIYaI synchrocyclotron. (W.H.K.)

8871 (TID-24667, pp 17-19) LNS-MIT 400 MeV LINEAR ELECTRON ACCELERATOR. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

The design objectives of the LNS-MIT 400-MeV electron linear accelerator are discussed. Topics include the accelerator and beam specifications, buildings and site, and beam transport system. (B.G.D.)

8872 (TID-24667, pp 20-1) LINEAR ELECTRON ACCELERATOR OF SACLAY. Leconte, P.; Schuhl, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The general features of the Saclay electron linear accelerator are presented. (B.G.D.)

8873 (TID-24667, pp 22-6) TENTATIVE NUMBERS AND LAYOUT OF THE 500 MeV HIGH-DUTY CYCLE PROJECT PROPOSED BY THE INSTITUTE FOR NUCLEAR RESEARCH AT AMSTERDAM, THE NETHERLANDS. deVries, C.

The design parameters, beam handling system and experimental program of the 500-MeV electron linear accelerator at Amsterdam are discussed. (B.G.D.)

8874 (TID-24667, pp 27-30) SOME INFORMATION ABOUT THE PRESENT ELECTRON SCATTERING FACILITY AT THE INSTITUTE FOR NUCLEAR PHYSICS RESEARCH ON AMSTERDAM. de Vries, C.; van Niftrik, G. J. C.; Bruinsma, P. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)).

An electron linear accelerator system is described for use in the electron-scattering program at the Institute for Nuclear Physics Research at Amsterdam. The program includes accurate determination of the electromagnetic structure of nuclear ground states and investigation of discrete energy levels and the giant resonance region through inelastic scattering. In addition to this program, radiochemistry and neutron time-of-flight studies will be undertaken. (B.G.D.)

8875 (TID-24667, pp 31-4) THE PRESENT STATUS OF THE FACILITIES FOR NUCLEAR PHYSICS RESEARCH AROUND THE LINEAR ELECTRON ACCELERATOR OF THE LABORATORI NAZIONALI DI FRASCATI. Schaerf, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati).

The measured performance of the electron linear accelerator at Laboratori Nationali di Frascati is described. A general layout of the existing buildings of the pion laboratory and linac tunnel is presented. (B.G.D.)

8876 (TID-24667, pp 39-89) HIGH RESOLUTION SPECTROMETER DESIGN STUDY OF MIT-LNS 400 MeV LINEAR ELECTRON ACCELERATOR. Kowalski, S.; Bertozzi, W.; Sargent, C. P. (Massachusetts Inst. of Tech., Cambridge).

An electron spectrometer based on the dispersed beam technique in which large beam dimensions are employed and the incident beam energy is correlated to position on the scattering target. The spectrometer resolution is shown to depend on certain factors such as angular kinematic broadening, target thickness (ionization straggling and multiple scattering related to kinematic effects), kinematic broadening due to energy spread in the incident beam, spectrometer broadband effect, and spectrometer aberrations. Mathematical formulations and a discussion are presented on the properties of the magnet spectrometer. Results of computations are presented for various types of spectrometer designs. The type solenoid needed to rotate the plane of dispersion of the incident beam from the horizontal plane to the vertical plane is examined. (B.G.D.)

8877 (TID-24667, pp 201-6) SOME DETAILS CONCERNING THE AMSTERDAM 180^0 EQUIPMENT. Van Niftrik, G. J. C.; de Vries, H.; de Vries, C. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)).

The geometry of the experimental hall; the spectrometer parameters; and the outgoing channel which consists of a Faraday cup, a quadrupole doublet, a non-interfering toroid monitor upstream to the target, and a feedback loop from cup to toroid allowing determination of current losses between target and cup are described. The beam optics for the last bending magnet are discussed. (B.G.D.)

8878 (TID-24667, pp 207-9) MAGNET FOR LARGE-ANGLE ELECTRON SCATTERING. Bergstrom, John C. (Massachusetts Inst. of Tech., Cambridge).

A magnet which satisfies the relation $\int_0^\infty B_z \; rdr = 0$ and can be used for 180° scattering is described. The advantages in using a magnet of this type are discussed. The beam optics for a particular geometry of this type magnet are investigated. (B.G.D.)

8879 (TID-24667, pp 210-11) BACKGROUND PROBLEMS IN THE 180^0 SET-UP. Ganichot, D.; Grossetete, B.; Isabelle, D. B. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

Electron scattering measurements at 180° were made using a liquid hydrogen target at 140 and 200 MeV. It is shown that the observed elastic cross sections are in good agreement, within statistical accuracy, with previous measurements. However, it is also shown that when the cross section was measured for an energy loss of 5% below the elastic peak, the experimental counting rate is much higher than what is predicted from the radiative tail calculation including Landau straggling and bremsstrahlung. An attempt to explain this is presented. (B.G.D.)

8880 (TID-24667, pp 512-14) ON THE POSSIBILITY OF OBTAINING BEAMS OF QUASI MONOCHROMATIC PHOTONS AT HIGH ENERGY. Schaerf, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Tamas, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A comparison of various techniques available for the production of monochromatic photon beams in the energy range around 100 MeV is presented. These techniques include coherent bremsstrahlung in crystals, positron annihilation in flight, and Compton scattering of a laser beam on a beam of high-energy electrons. (B.G.D.)

8881 (TID-24667, pp 583-96) YIELDS OF PIONS AND MUONS FROM MEDIUM ENERGY ELECTRON LINEAR ACCELERATORS. Duclos, J.; Miller, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Williamson, C. F. (Massachusetts Inst. of Tech., Cambridge).

It is shown that the calculation of the photopion yields depends directly upon the measurements of the photoproduction cross sections. A discussion is on the relation of target materials and geometry to pion yields. The estimation of intensities of muon beams from the decay of pions and the number of stopped muons and pions as well as the purity of the muon and pion beam are examined. (B.G.D.)

8882 (TID-24667, pp 597-600) MUON BEAMS AT MIT AND SACLAY. Duclos, J.; Priou, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A study of the possibilities of the MIT and Saclay linear accelerators for producing stopped muons is discussed. (B.G.D.)

8883 (TID-24667, pp 601-2) SUPERCONDUCTING SOLENOID TRANSPORT SYSTEM FOR HIGH INTENSITY STOPPED MUON BEAMS. Williamson, Claude F. (Massachusetts Inst. of Tech., Cambridge).

An idealized solenoid for transporting low-energy pions and capturing the resultant decay muons is considered. (B.G.D.)

8884 (TID-24667, pp 603-7) EVALUATION OF ALS (SACLAY) AND MIT-LINS LINACS AS SOURCES OF STOPPED NEGATIVE PIONS AND MUONS WITH RESPECT TO THE MESON FACTORIES. Williamson, Claude F. (Massachusetts Inst. of Tech., Cambridge).

In order to appreciate the possibilities of the new generation of medium energy electron linear accelerators as sources of low energy pions and muons, a comparison was made of the stopped pion rate from the Saclay and MIT-LNS linear accelerators and the proton linear accelerators being constructed as meson factories at Los Alamos (LAMPF), Zurich, and Vancouver. (B.G.D.)

8885 (TID-24667, pp 640-50) CRYSTAL DIFFRACTION SPECTROMETERS: POSSIBLE USES AT A HIGH INTENSITY ELECTRON LINAC. Shafer, R. (Massachusetts Inst. of Tech., Cambridge).

A general discussion of crystal diffraction and crystal spectrometers is presented. The possible applications of crystal spectrometers at MIT-LNS electron linear accelerator are examined. These are: direct study of low-energy gamma de-excitation of nuclear states produced by the primary beam (including bremsstrahlung), indirect study of high-energy gamma de-excitation, using the crystal as an energy-band filter in conjunction with a germanium detector, and study of pionic and muonic x-rays. (B.G.D.)

8886 (UCRL-18454) TRANSVERSE SPACE-CHARGE EFFECTS IN CIRCULAR ACCELERATORS. Sacherer, Frank James (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 30, 1968. Contract W-7405-eng-48. 123p. Dep. CFSTI.

Thesis.

The particles in an accelerator interact with one another by electromagnetic forces and are held together by external focusing forces. Such a many-body system has a large number of transverse modes of oscillation (plasma oscillations) that can be excited at characteristic frequencies by errors in the external guide field. In Part I one mode of oscillation is examined in detail, namely the quadrupole mode that is excited in uniformly charged beams by gradient errors. Self-consistent equations of motion are derived for the beam envelope and these equations are solved for the case in which the space-charge force is much less than the external focusing force, i.e., for strong-focusing synchrotrons. It is shown that the resonance intensity is shifted from the value predicted by the usual transverse incoherent space-charge limit; moreover, because the space-charge force depends on the shape and size of the beam, the beam growth is always limited. For gradient errors of the magnitude normally present in strong-focusing synchrotrons, the increase in beam size is small provided the beam parameters are properly chosen; otherwise the growth may be large. Thus gradient errors need not impose a limit on the number of particles that can be accelerated. In Part II the other modes of collective oscillation that are excited by machine imperfections are examined. For simplicity only one-dimensional beams that are confined by harmonic potentials and only small-amplitude oscillations are considered. The linearized Vlasov and Poisson equations are used to find the twofold infinity of normal modes and eigenfrequencies for the stationary distribution that has uniform charge density in real space. In practice, only the low-order modes (the dipole, quadrupole, sextupole, and one or two additional modes) will be serious, and the resonant conditions for these modes are located on a tune diagram. These results, which are valid for all beam intensities, are compared with the known eigenfrequencies for the stationary distribution that has uniform particle density in phase space, and are extrapolated to the Gaussian distribution observed in the Brookhaven AGS. (auth)

8887 FOKUSIROVKA ZARYAZHENNYKH CHASTITS KVADRUPOL'NYMI LINZAMI. (Charged Particle Focusing by Quadrupole Lenses). Yavor, S. Ya. Moscow, Atomizdat, 1968. 264p.

Theoretical and experimental data on charged particle behavior in quadrupole lenses are briefly reviewed. Electric fields and magnetic quadrupole lenses, their electron-optic properties in the pre-axial region and geometric and chromatic aberrations are discussed in the first five chapters. Construction of quadrupole lens systems and use of quadrupole lenses in various installations are covered in the sixth and seventh chapters. Singularities in the construction of various electric and magnetic lenses and experimental methods are discussed in the last chapter. (200 references) (R.V.J.)

8888 VACUUM SYSTEMS ASSOCIATED WITH THE AAEC'S 3 MeV ACCELERATOR. Broe, H. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Vacuum, 18: 637-40 (Dec. 1968).

Operation of the 3 MeV Van de Graaff accelerator with a number of exit beam tubes requires a complex arrangement of vacuum equipment. The accelerating tube must be maintained at 10^{-5} torr or better, with a hydrogen flow of 10 atmospheric cc/hr. Individual beam tubes must be equipped with beam handling and target facilities and be maintained at 10^{-5} to 10^{-8} torr, according to the type of experiment involved. A description is given of the system used at the AAEC Research Establishment, Lucas Heights, NSW to achieve reliability as well as flexibility in the number and type of experiments performed at any one time. (auth)

8889 DESIGN OF BEAM LINES WITH HIGH RESOLVING POWER. Reeve, P. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 67: 13-21(Jan. 1, 1969).

A systematic method of designing beam lines, which reduces the energy spread and emittance of particle beams from accelerators to match target requirements is discussed. (auth)

8890 NOVEL TIME-OF-FLIGHT METHOD AND ITS APPLICATIONS IN NUCLEAR REACTION STUDIES. Brueckmann, H.; Haase, E. L.; Kluge, W.; Schaenzler, L. (Univ., Karlsruhe, Ger.). Nucl. Instrum. Methods, 67: 29-37(Jan. 1, 1969).

A time-of-flight method designed for accelerators with high particle burst rates is described. The method uses an independent energy measurement to resolve the ambiguity which arises when the primary pulse separation, length of flight path and energy range are outside the limits of conventional time-of-flight technique. The system can be used for an accurate determination of the energy of neutrons and charged reaction products, for very precise calibration of the primary beam energy, and for particle identification in case of charged reaction products. The method is being used at the Karlsruhe isochronous cyclotron for nuclear reaction studies. In the course of investigations of the cyclotron beam properties, burst widths down to 0.2 nsec were measured. (auth)

8891 SECTORED ISOCHRONOUS RING FOR ACCELERATING HEAVY IONS. Schatz, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 67: 103-8(Jan. 1, 1969).

An accelerator capable of accelerating heavy ions to energies around 7 MeV/nucleon is proposed. It consists of a pre-stripper, which may be either an electrostatic accelerator, a cyclotron, or a linac, and an isochronous cyclotron with separated magnets. Different factors relevant to the design of the isochronous ring and to the choice of the pre-stripper are discussed. It is concluded that the construction of such an accelerator does not present problems which go beyond the present state of cyclotron technology. (auth)

8892 STUDY OF THE POLE SHAPE OF GRADIENT MAGNETS FOR A STRONG FOCUSING SYNCHROTRON. Kihara, M.; Doke, T. (Tokyo Univ.). Nucl. Instrum. Methods, 66: 45-53 (Dec. 1, 1968).

The possibility of improving the high field quality of a strong focusing synchrotron magnet by suitable choice of the pole shape is investigated by computer calculation. It is shown that there is an optimum pole shape on the high field side for a given pole width. With the optimum pole shape the sextupole and octupole components of the field strength can be made appreciably small. Also, by using the results of the calculation, the approximate design of the synchrotron magnet is described. (auth)

8893 STUDY OF THE TIME STRUCTURE OF A PULSE OF DEUTERONS AT 28 MeV IN VIEW OF TIME-OF-FLIGHT EXPERIMENTS. Chemarin, M.; Feuvrais, L.; Gouanere, M.; Pigneret, J.; Vidal, J. L. (Univ., Lyon). Nucl. Instrum. Methods, 66: 109-13(Dec. 1, 1968). (In French).

The time structure of the beam, extracted from the synchrocyclotron at the Nuclear Physics Institute of Lyon has been studied by means of an electronic method. The elementary pulse width (2.8 ns) allows time-of-flight experiments whose characteristics are given. (auth)

8894 SELF CONTROLLED PULSING OF A PENNING ION SOURCE. Marghitu, S.; Radu, A.; Teodorescu, I. E. (Inst. for Atomic Physics, Bucharest). Nucl. Instrum. Methods, 66: 105-8(Dec. 1, 1968).

A Penning ion source in a pulsed operation is presented. The distinguishing feature of the pulse circuit is its simplicity and reliability. The regulation of some source parameters (repetition frequency, pulse duration and discharge current amplitude) is based on the interdependence between the pulsing circuit and ion source operating conditions, the use of a synchronizing generator being not necessary. (auth)

8895 PREPARATION OF LARGE SURFACE URANIUM DIOXIDE TARGETS. Mihailova, V. Z.; Dermendzhiev, E. G. (Inst. of Physics and Nuclear Research Center, Sofia). Nucl. Instrum. Methods, 66: 25-8(Dec. 1, 1968).

A method, based on the spontaneous deposition of uranium dioxide from a uranyl nitrate solution on an aluminum foil, for preparing targets with thickness of about 0.05 to 2.8 mg/cm^2 and an active area up to 70 cm^2, is reported. The effect of various factors, such as temperature, concentration and pH of the solution on the process of deposition, as well as on the quality of the obtained layers, was studied. The homogeneity of the targets was estimated by relative measurements of their alpha emission, using an ionization chamber. It was shown that the maximum standard deviation of homogeneity varies from 1% to 6%. (auth)

8896 IMPROVEMENTS RELATING TO MULTIPLE MAGNETIC LENSES. (to Centre National de la Recherche Scientifique). British Patent 1,135,249. Dec. 4, 1968. Priority date Aug. 16, 1965, France.

The design of a permanent magnet multipole magnetic lens with variable convergence for focusing charged-particle beams is described. (W.H.K.)

8897 PEAK CURRENT METER USING A TUNNEL DIODE FOR THE SENSING ELEMENT. Biggerstaff, J. A.; Nutt, R. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 66: 173-6(Dec. 1, 1968).

An instrument was developed to measure the peak current of pulses with widths varying over a broad range from some μsec to less than a nsec. The instrument's basic advantages over other such instruments are its insensitivity to changes in the pulse repetition rate above approximately 17 kc/s and pulse width. The error introduced by decreasing the pulse width from 1 μsec to 0.45 nsec is <5%. The sensing device for the instrument, a low-capacitance tunnel diode, is biased in a bistable state with the bias current being adjusted by a pulse-rate feedback network. The feedback forces the sum of the signal current and the bias current to just equal the peak current of the tunnel diode. This condition imposed on the tunnel diode causes the bias current to be linearly related to the peak signal current. (auth)

8898 SIMPLE CONTROL METHOD OF BEAM TRANSPORT SYSTEM. Kumabe, I. (Kyoto Univ.). Nucl. Instrum. Methods, 66: 54-6(Dec. 1, 1968).

A simple analog control system for a beam transport system is proposed. Using a combination of a simultaneous current control system and slit stabilizers, the magnetic fields of several magnets can be simultaneously controlled with only manual control of one potentiometer. This control system was applied to the beam transport system of the tandem laboratory in Kyoto University and is being used successfully. A simple switching method of beam courses in a switching magnet is also presented. (auth)

8899 MODIFICATION OF AN APPARATUS FOR DISCHARGE OF COCKCROFT-WALTON ACCELERATORS. Pajares, J. A.; de Burgos, E.; Campos, J. (Junta de Energie Nuclear, Madrid). An. Fis., 64: 127-8(Mar.-Apr. 1968). (In Spanish).

An apparatus for controlling discharge of a Cockcroft–Walton accelerator was modified by making the multichannel analyzer automatic and independent of the accelerator. The simplified logic schematic of the apparatus is given. (J.S.R.)

8900 THE CERN INTERSECTING STORAGE RINGS. Borer, Jean (CERN, Geneva). Ind. At., 12: No. 9-10, 65-74(1968). (In French).

Proton intersecting storage rings are now being constructed at CERN. By 1971, they will make it possible to move into the field of exploration of very high energy atomic phenomena. The chief parameters of this machine are presented and the component elements including the magnet system, system of high frequency acceleration, the transfer and injection of the beam, the vacuum, the checking system, and the foundation structures are discussed. (auth)

8901 DESIGN FOR A HIGH-RESOLUTION REACTION-PRODUCT ANALYSING SYSTEM. Klank, B.; Lind, D. A.; Johnson, R. R. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods, 67: 61-70(Jan. 1, 1969).

A graphical design of a double dispersion system using two edge focusing magnets is presented. A mass-energy product of 80 with a momentum resolution of 10^4 is achieved with an acceptance solid angle of 3 msterad or greater. The magnetic field is uniform and restricted to values less than 15 kg in the median plane of the pole gap. Two deflections are used with an intermediate image so that very high rejection of unwanted particles is possible. Both intermediate and final focal planes are suited for installation of position sensitive detectors, i.e., solid state or spark counters. (auth)

8902 ASSOCIATED PARTICLE METHOD FOR MEASURING TOTAL PROTON REACTION CROSS SECTIONS AT 15.8 MeV. Hojvat, C.; Jones, G. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 66: 13-24(Dec. 1, 1968).

Measurements of total proton reaction cross sections by the attenuation method involve the determination of the ratio of particles absorbed in the target to those transmitted. The associated particle technique has been adapted to enable total reaction cross section measurements for the 15.8 MeV protons from the ^{2}H(^{3}He,p)^{4}He reaction. Detection of the ^{4}He defines the spatial collimation and time of arrival of the associated proton. Anticoincidence and coincidence measurements between the ^{4}He's and the associated proton after traversal of the absorbing target, are performed. The ratio of these measurements yield values for the attenuation of the proton beam in the target. Measurements were performed for targets of gold and natural copper and iron. The cross sections so obtained were measured to an accuracy of 10%. A number of improvements to decrease the uncertainty to better than 5% are also discussed. (auth)

8903 POLARIZED TARGETS. Gurevich, G. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 41: 146-64(1968). (In Russian).

A brief review is given of experimental data on polarized targets and method for producing oriented nuclei. The included tables 1 and 2 exhibit the basic characteristic conditions for polarization (temperature, magnetic field, radiofrequency, etc.) and the parameters of polarization achieved. The table 1 includes data on nuclei oriented by means of dynamic and the table 2 data on nuclei oriented by static methods. 273 references. (R.V.J.)

8904 HIGH POWER ELECTRON GUN WITH ELECTRON BOMBARDED APERTURED CATHODE HAVING A CONCAVE EMISSION SURFACE. Schiller, Siegfried; Lenk, Peter (to VEB Lokomotivbau-Elektrotechnisch Werke Hans Beimler). U. S. Patent 3,406,305. Oct. 15, 1968. Filed Oct. 6, 1965.

The invention relates to an electron gun in which a cathode having a curved emission surface with a central aperture therethrough produces an axially symmetrical electron beam. Spaced from the cathode an anode is disposed with a transit aperture therein. The inner diameter of the annular cathode is defined by the ratio a:b in which b is the distance from the periphery of the transit aperture of the anode to the periphery of the inner diameter of the cathode and a is the distance from the same periphery of the transit aperture to the outer diameter of said annular cathode, such ratio being preferably in the range of 1.2 to 1.8. (U.S. Pat. Gazette)

8905 HIGH CURRENT DUOPLASMATRON HAVING AN APERTURED ANODE POSITIONED IN THE LOW PRESSURE REGION. Chopra, Kasturi L.; Randlett, Myron Ronald (to Kennecott Copper Corp.). U. S. Patent 3,408,283. Oct. 29, 1968. Filed Sept. 15, 1966.

A duoplasmatron ion source in which an electric arc is used to change an ionizable gas into a plasma from which an ion beam can be extracted is described. (B.G.D.)

8906 LINEAR ELECTRON ACCELERATOR. Kimura, Hiroshi (to Hitachi Ltd.). Japanese Patent 1968-17359. July 22, 1968. Filed Oct. 29, 1964.

The advantages to the proposed method are the following: attainment of the stable operation of a high-frequency output tube within less than ten minutes; and exchange of the photographic films and movement of subject bodies in a safe manner. While the high-frequency output tube source for operating the tube is in the condition of operation, the switch for the electron-gun power source is cut off. In conjunction with this, the output of the focusing coil power source is cut off simultaneously. The switch for an electron-gun power source is made into an electrical lock, which is also a lock for the exit-entrance door. The switch for an electron-gun power source is actuated by the switch for the entrance-exit door. (NSA of Japan)

8907 ORBIT PROPERTIES OF THE ISOCHRONOUS CYCLOTRON RING WITH RADIAL SECTORS. Gordon, M. M. (Michigan State Univ., East Lansing). Ann. Phys. (N.Y.), 50: 571-97 (1968).

The isochronous cyclotron considered consists of a ring of radial magnet sectors separated by straight sections. The general features of such cyclotrons are discussed, and a complete analy-

sis is presented of their orbit properties using the hard-edge approximation. This analysis proceeds through the transfer matrix technique, which is simplified by the symmetry of the magnet structure; the only complication arises from the inconstancy of the magnetic field index resulting from the isochronism condition. Computed orbit properties are presented and discussed for a wide variety of possible geometries; these properties include the extreme values of the beam widths, as well as the focusing frequencies, as a function of the energy. Problems associated with certain resonances are also considered. The results indicate that isochronous cyclotrons of this type should be quite capable of producing proton beams at energies up to about 500 MeV. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 8642 and 8954.

8908 (UJV-2080-F) ANOMALOUS CAPTURE OF THERMAL POLARIZED NEUTRONS IN PERFECT FERROMAGNETIC SINGLE CRYSTALS. Michalec, R.; Stich, V.; Galociova, D.; Chalupa, B.; Bischof, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1968. 6p. Dep.

The effect of the electronic shell of atoms on the capture of thermal polarized neutrons by nuclei arranged in the lattice of perfect ferromagnetic single crystals was investigated. (auth)

8909 NEUTRON RESONANCE AREA ANALYSIS WITH MUTUAL-INDICATION. Fleck, C. M.; Weisshaeupl, H. A. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 66: 141-8(Dec. 1, 1968).

The mutual-indication method for the determination of the neutron resonance parameters σ_r and Γ is applied to thin foils, including detailed treatment of Doppler broadening. The resonance parameters of both resonances can be determined without variation of thickness or temperature for additional equations by combining self-indication and mutual-indication methods. On the other hand, self-indication is replaced by mutual-indication if the capture method does not seem to be appropriate for the measurement of the resonance or if the γ quanta from the absorption foil disturb the measurement. Corrections for wing contribution, multi-level effects, expansion errors, energy dependence of the flux, and $1/\nu$ factor in the cross section are calculated in detail. (auth)

8910 SELECTION OF THE FOREIGN NEUTRON RESONANCE IN MUTUAL-INDICATION. Fleck, C. M.; Weisshaeupl, H. A. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 66: 149-53(Dec. 1, 1968).

If in the mutual-indication method for the determination of the neutron resonance parameters σ_r and Γ an appropriate, known partner for the unknown resonance is to be selected, statements can be made concerning the best relations of $2\Delta E_r/(\Gamma_i + \Gamma_j)$ and Γ_j/Γ_i. Criteria are given for the value of the expected error in the resonance parameters, and furthermore it is shown for which values of $2\Delta E_r/(\Gamma_i + \Gamma_j)$ use of the mutual-indication method is inappropriate. The statistical error shows a resonance shape, the peak of which can be avoided by changing the temperature of the target. (auth)

8911 SLOW-NEUTRON SCATTERING BY DIPHENYL. Sprevak, D.; Koppel, J. U. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 80-7(Jan. 1969).

A scattering kernel for liquid diphenyl was determined from a model for the diphenyl molecule in which the carbon and hydrogen ztoms make harmonic oscillations about their equilibrium position. The hindered translations and rotations of the molecule as a whole, which are characteristic of the liquid state, were considered as free translations of the molecule to which an effective mass was associated. A set of interatomic force constants which describes the vibrational motions of the molecule was found and then used for a complete normal-mode calculation. These force constants were calculated, using a modified least-squares technique which gives the best fit for the vibrational frequencies of the molecule measured by optical techniques. The amplitude vectors calculated from the computed set of force constants were used, together with the measured vibrational frequencies, to construct the weighted frequency spectrum used in the slow-neutron calculations. The scattering law was computed, in the harmonic approximation, by means of the code GASKET. The code FLANGE was used to interpolate the scattering law and to produce the scattering kernel. The total scattering cross section, the single differential cross section, and other neutron parameters were calculated and compared with experimental data with gratifying results (auth)

8912 EXPERIMENTAL ANISOTROPIC SOURCE DISTRIBUTION FOR SPATIALLY DEPENDENT THERMAL-NEUTRON SPECTRUM CALCULATIONS. Gozani, Tsahi; Trimble, G. D. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 144-9(Jan. 1969).

Assumptions used in the P_2 source calculation, particularly for the exponent k in the expression for the energy dependence of flux in the epithermal region, are discussed. Suggestions are made on how to make a direct measurement of the P_1 component of the slowing down source. Experimental values are compared with the predictions of diffusion theory. It is clearly demonstrated that in systems where strong discontinuities in scattering amplitudes occur, the simple approximation for k is inadequate. (J.W.R.)

8913 NEUTRON-WAVE PROPAGATION THROUGH A CRYSTALLINE MODERATOR. III. ICE. Tewari, S. P.; Kothari, L. S. (Univ. of Delhi). Nucl. Sci. Eng., 35: 152-4(Jan. 1969).

Neutron wave propagation through ice was studied by multigroup diffusion theory. One- and two-phonon scattering kernels were calculated using the Debye frequency distribution function. Various diffusion coefficients were calculated and were compared with experimental values. (J.W.R.)

8914 DIFFUSION PARAMETERS OF THERMAL NEUTRONS IN PARAFFIN. Sakamoto, Shigeyasu; Nakadoi, Syozo (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu, 1968: No. 1, 17-21(Nov. 1968). (In Japanese).

Asymptotic decay constants of thermal neutron fields were measured for cylindrical paraffin assemblies with geometric bucklings from 0.1 to 0.8 cm^{-2}. The absorption probability $\lambda_a = \bar{\nu}\Sigma_a$, the thermal neutron diffusion coefficient D_0, and the diffusion cooling coefficient C are obtained from least-squares fit to the decay constants λ vs geometrical buckling B_g^2 data. The diffusion parameters λ_a of 6,580 sec^{-1}, D_0 of 22,400 cm^2 sec^{-1}, and C of 4100 cm^4 sec^{-1} are found. (NSA of Japan)

8915 GAMBLE-5. Dorsey, J. P.; Froehlich, R. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 157-8(Jan. 1969).

The computer program GAMBLE-5 for solving homogeneous two-dimensional multigroup diffusion theory equations with arbitrary scattering and fission transfer is described. The program is written in FORTRAN IV for the UNIVAC 1108. (J.W.R.)

8916 MODERATOR STUDIES FOR A REPETITIVELY PULSED TEST FACILITY (RPTF). Fluharty, R. G. (Idaho Nuclear Corp., Idaho Falls); Simpson, F. B.; Russell, G. J.; Menzel, J. H. Nucl. Sci. Eng., 35: 45-69(Jan. 1969).

Pulsed reactors are being investigated for the purpose of producing high-intensity pulsed-neutron beams for research. Leakage-emission-time-distribution measurements as a function of neutron energy were carried out using the Rensselaer Polytechnic Institute (RPI) electron linear accelerator in conjunction with a disk chopper and neutron diffraction spectrometer. Data were obtained simultaneously with the chopper and crystal spectrometer by looking at opposite sides of the moderator. This experiment was designed to investigate the importance of different variables in determining the pulse characteristics of moderators. The eventual objective is to optimize the maximum thermal-neutron intensity and minimum pulse width from pulsed-fission-neutron sources. Neutron time and energy distributions were measured for light water, polyethylene, Lucite (a metacrylate plastic), powdered zirconium hydride, and ammonia. The water, polyethylene, and zirconium-hydride samples were measured at room temperature and all the materials except water were also measured at liquid-nitrogen temperature. The effects on pulse characteristics of homogeneously poisoning light water samples were studied, as well as the effects of heterogeneously poisoning polyethylene. The effect of varying the thickness of the moderator was also investigated. Pulse widths at half-maximum of 11 μsec at 0.05096 eV and 24 μsec at 0.01274 eV were observed for solid ammonia and heterogeneously poisoned polyethylene samples. For neutron energies between 0.08 and 0.01274 eV, solid ammonia gave the best observed figure of merit, peak intensity/$(FWHM)^2$. The data show that neutron pulse characteristics from a moderator can be altered significantly by varying the material and its temperature, as well as by adding poison and optimizing the geometry. Time distributions were observed in the energy region of 0.012 to 0.63 eV. The time resolution, in this energy region, for the diffraction spectrometer ranged from 2.8 to 10.8 μsec compared with 7.6 μsec for the chopper. (auth)

8917 PULSED-NEUTRON DIFFUSION PARAMETERS IN SPHERICAL WATER SYSTEMS. Nassar, Shawky F.; Murphy, Glenn (Iowa State Univ. of Science and Tech., Ames). Nucl. Sci. Eng., 35: 70-9(Jan. 1969).

The diffusion parameters of light water were measured by the pulsed-source method. The neutron bursts were produced from a Texas Neutron Generator by pulsing the ion source and using the $^3H(d,n)\,^4He$ reaction. Neutrons were injected into spherical volumes of H_2O and the decay constants of the neutrons were determined by means of an enriched BF_3 miniature proportional counter. Neutron lifetime measurements were performed on small and large water samples with values of the geometric buckling from

0.035 to 0.655 cm^{-2}. A harmonic analysis was conducted for the large geometries, while the waiting time method was used for the smaller ones. In the harmonic analysis, it appeared that a detector in a sphere is more sensitive to neutron fluctuation with time than it would be in a rectangular or cylindrical system. The diffusion parameters, D_0 and C, were determined by fitting the decay constants to the equations $\lambda_0 = \alpha_0 + D_0B_S^2 - CB_S^4$ and $\lambda_0 = \alpha_0 + D_0B_T^2 - CB_T^4$, where B_S^2 and B_T^2 are the geometric and the corresponding transport buckling, respectively. The second fit gave a lower standard deviation of C than did the first fit. (auth)

8918 NEUTRON SPECTRUM FROM A FISSION SOURCE IN GRAPHITE. Profio, A. E.; Antunez, H. M.; Huffman, D. L. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 91-103(Jan. 1969).

Time-of-flight measurements of the neutron angular flux spectrum in graphite were made to provide a standard of comparison for neutron penetration calculations. The spectrum from 0.002 eV to 15 MeV was measured with an accuracy of ±13 to 32% and a resolution of ±2 to 10%, at angles from 0 to 60° and penetrations to 66 cm. Comparisons with Monte Carlo and discrete ordinates calculations using ENDF/B cross sections indicate fairly good agreement except in resonances and near zero degrees for discrete ordinates. Scalar fluxes were also calculated with the moments method. (auth)

8919 THE EFFECT OF CHEMICAL BINDING ON THE NEUTRON SCATTERING CROSS SECTION OF CARBON ATOM IN URANIUMMONOCARBIDE. Saad, Masoud A. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 14: 72(Jan.-Feb. 1969). (In German).

The neutron total cross section for UC was measured from 0.034 to 0.18 eV using a crystal spectrometer, and the total cross section per C atom in UC was extracted. (D.C.W.)

8920 TOTAL CROSS SECTION OF GLASSY CARBON FROM 0.001 TO 0.1 eV. Iizumi, Masashi; Ayao, Shinji (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 649-51(Dec. 1968).

The neutron total cross section of glassy carbon was measured from 0.001 to 0.1 eV by the transmission method using a neutron spectrometer in the JRR-3 reactor. The results show that glassy carbon has a large total cross section even below the Bragg cutoff of graphite. Small-angle scattering by glassy carbon was also observed in order to study the growth of graphite structure. Incident neutrons of energies below a certain level were found to generate scattered neutrons too weak to observe. The limit was about 0.04 eV (1.43 Å) for measuring the angular distribution of the scattered neutrons, at which level it was found to be almost Gaussian with a half-width of 0.075 rad. (D.C.W.)

8921 A STUDY OF TWO-LEVEL INTERFERENCE IN NEUTRON CROSS SECTIONS. Garrison, John D. (Gulf General Atomic Inc., San Diego, Calif.). Ann. Phys. (N.Y.), 50: 355-89 (1968).

Interference between resonances in neutron cross sections was studied using the two-level approximation. Use was made of the mathematical connection between the R-matrix and the Kapur–Peierls theories which provides two sets of resonance parameters for each cross section allowing an improved measure of the effects of interference. The mathematical properties of the cross section when the resonance widths are large compared to the spacing were also obtained. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 7736, 8463, 8936, 8937, and 9027.

8922 (LA-3997) RESONANT FINAL STATE INTERACTIONS IN ^{3}He(d,tp)^{1}H, ^{3}H(t,tp)n, AND ^{3}H(d,tp)n REACTIONS. Newsome, R. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Aug. 27, 1968. Contract W-7405-eng-36. 28p. Dep. CFSTI.

A kinematically unique two-parameter experiment was used to search for resonant interactions between pairs of particles in the three-body final states of the reactions studied. The center-of-mass excitation range was from 20.5 to 29.3 MeV above the ^{4}He ground state for the t + p system, and from 21.0 to 29.1 MeV above the ^{4}He ground state for the t + n system. The reaction ^{3}He(d,tp)^{1}H with 15-MeV incident deuterons yielded a distinct resonance in the t + p system at 21.5 ± 0.1 MeV, with a width of approximately 1 MeV. For this same reaction with 20-MeV incident deuterons, the peak cross section for this t + p resonance shifted to 22.0 ± 0.2 MeV, with a width of approximately 2 MeV. There is weak evidence that this latter resonance can be resolved into resonances at approximately 21.6 and 22.2 MeV. Data from the reaction ^{3}H(d,tp)n, which were obtained with 20-MeV incident deuterons, are also consistent with the existence of a broad resonance in the t + p system at approximately 22 MeV above the ^{4}He ground state. The reaction ^{2}H(t,tp)n was run with 21-MeV tritons; however, the breakup spectra are unfortunately dominated by phase space and the spectator pole-type breakup of the deuteron. Evidence for other possible resonance is inconclusive. (auth)

8923 (TID-24667, pp 397-8) HIGH ENERGY (p-^{4}He) ELASTIC SCATTERING. Gotow, K. (Virginia Polytechnic Inst., Blacksburg. Virginia Associated Research Center, Blacksburg).

The preliminary results of an experiment involving proton elastic scattering by ^{4}He at 586 MeV (1.21 BeV/c) are presented. The angular distribution has a sharp minimum at 34° in the center-of-mass system. (D.C.W.)

8924 (TID-24667, pp 399-416) WITCHCRAFT IN THE DEUTERON. Kisslinger, L. (Case-Western Reserve Univ., Cleveland, Ohio).

An analysis of high-energy proton–deuteron backscattering is outlined. It is shown that the virtual baryonic resonances excited through the strong interaction in nuclear matter give rise to experimentally verifiable effects and that 0.5% of the N*(1688) resonance in the wave function can account for one-half of the pickup peak in proton–deuteron scattering. (D.C.W.)

8925 (TID-24667, pp 503-4) THE D(p,γ)^{3}He REACTION AT 156 MeV, TIME REVERSAL INVARIANCE, AND THE WAVE FUNCTION OF ^{3}He. Radvanyi, Pierre (Paris Univ., Orsay (France). Institut de Physique).

The differential cross section for the reaction D(p,γ)^{3}He at 156 Mev was measured over the angular range from Θ_γ = 20 to 150° in a coincidence experiment. An extrapolated total cross section of 1.4 ± 0.3 μ barn was obtained. The results were found to be in agreement with data on the inverse reaction ^{3}He(γ,p)D, providing a test of time reversal invariance. (D.C.W.)

8926 (TID-24667, pp 555-66) NUCLEON COMPTON AND NUCLEAR THOMSON SCATTERING. Frisch, David (Massachusetts Inst. of Tech., Cambridge).

The scattering of photons by protons, deuterons, and complex nuclei at energies below 250 MeV is discussed. Specifically, Compton scattering by protons and deuterons, and Thomson scattering by complex nuclei, are examined. Theoretical predictions are compared with experimental data. (D.C.W.)

8927 POLARIZATION IN PROTON-^{4}He SCATTERING AT 540 MeV. Gotow, K. (Virginia Polytechnic Inst., Blacksburg); Boschitz, E. T.; Roberts, W. K.; Vincent, J. S.; Gugelot, P. C.; Perdrisat, C. F.; Swenson, L. W. Phys. Rev. Lett., 21: 1816-19(Dec. 30, 1968).

The asymmetry of polarized protons scattered from ^{4}He was measured for laboratory angles between 4 and 42° at the proton energy of 540 MeV. The result is compared with the elastic p-^{4}He scattering cross section at 588 MeV. (auth)

8928 ELECTROMAGNETIC RADII OF TRITIUM. Moskalev, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 727-30(Oct. 1968). (In Russian).

Electric and magnetic radii of tritium were calculated in a theory with zero-range nuclear forces. The difference between the calculated values and the experimental values is 10 to 20%. (auth)

8929 THE ENERGY DEPENDENCE OF THE ^{2}H(d,p)^{3}H REACTION AT LOW ENERGY. Franz, H. W.; Fick, D. (Univ., Erlangen-Nuernberg, Ger.). Nucl. Phys., A122: 591-605(1968). (In German).

The proton angular distribution of the reaction ^{2}H(d, p)^{3}H was measured with polarized and unpolarized deuterons. The results were compared with an improved theory of Rook and Goldfarb. At the energies 80 ≦ E ≦ 150 keV, the polarization efficiencies and the anisotropy factor were measured. They show a resonance-like behavior at E ≈ 105 keV. (auth)

8930 APPROXIMATIONS IN THE CALCULATION OF PROTON–DEUTERON ELASTIC SCATTERING AT MEDIUM ENERGY. L'Huillier, M. (Institut de Physique Nucleare, Orsay, France). Nucl. Phys., A122: 667-74(1968). (In French).

Usual calculations of the proton-deuteron elastic scattering cross section are analyzed for energies of about 100 MeV. Several approximations usually performed in the impulse term, such as the factorization method and the introduction of the free nucleon–nucleon scattering operator (on the energy shell) are studied. The use of a simple separable S-interaction allows the derivation of a ratio between the exact and approximate values of the impulse approximation term. The variations with the incident energy or the center-of-mass angle are small, and the corrections

are not greater than 10%. This result is due to the properties of the deuteron wave function. It is concluded that these approximations are not responsible for the observed disagreement with respect to experiments and that consequently a multiple scattering mechanism must be involved. (auth)

8931 TRITON BINDING ENERGY CALCULATIONS WITH REALISTIC LOCAL POTENTIALS. Humberston, J. W.; Hawkins, S. M.; Hennell, M. A.; Wallace, J. B. G. (Univ. Coll., London). Nucl. Phys., A122: 675-8(1968).

Derrick's formulation of the triton binding energy problem was checked, and calculations were performed for the Hamada–Johnston and Brueckner–Gammel potentials using trial functions previously used by Delves and Blatt. Good agreement is obtained with these earlier calculations. (auth)

8932 POLARIZATION IN THE ELASTIC SCATTERING OF 9.5- AND 21.6-MeV PROTONS BY DEUTERONS. Megaw, J. H. P. C. (Queen's Univ., Belfast); Johnston, A. R.; Gibson, W. R.; Kingston, F. G. Nucl. Phys., A122: 689-96(1968).

Polarization in the elastic scattering of protons by deuterons was measured at 21.6 MeV in the angular range 93 to 160° cm and at 9.5 MeV in the range 20 to 160° cm. The polarized proton beam of the RHEL linear accelerator was used in conjunction with deuterated polyethylene targets and a double-focusing magnetic spectrometer. The 21.6-MeV results extend earlier measurements at 22 MeV to larger angles but indicate a higher angle of cross-over from positive to negative polarization and a smaller maximum value of negative polarization than before. The backward positive maximum is in good agreement with the n-d data. At 9.5 MeV, the present results are in good agreement with a previous measurement at 10.0 MeV and extend the angular range to 20° cm. Although a dip to negative polarization in this region has been reported at 11.0 MeV, no evidence for this is found at 9.5 MeV. (auth)

8933 NUCLEON–NUCLEON INTERACTION AND TRITON BINDING ENERGY. Kok, L. P. (State Univ., Groningen, Netherlands); Erens, G.; van Wageningen, R. Nucl. Phys., A122: 684-8(1968).

The Hulthén and the generalized Bargmann potential, which are both in a certain sense equivalent to the Yamaguchi separable two-nucleon interaction, are shown to give a rather different triton binding energy. The implications of this result are discussed. (auth)

8934 ENERGY DEPENDENCE OF THE POLARIZATION OF NEUTRONS FROM THE REACTION $^3H(d,n)^4He$ AT 70°(LAB.) AND DEUTERON ENERGIES BELOW 2 MeV. Hentschel, Guenther (Univ., Tuebingen, Ger.). Z. Phys., 219: 32-43(1969). (In German).

The polarization of neutrons from the d–t reaction was measured at seven deuteron energies between 0.3 and 1.83 MeV at 70° (lab.). In a time-of-flight experiment with a high-pressure helium gas scintillator as a scatterer, the left and right scattered neutrons were detected in two plastic scintillators. The phase shifts from Hoop and Barschall were used to deduce neutron polarizations from scattering asymmetries. The neutron polarizations are at E_d = 0.3, 0.6, 0.95, 1.26, 1.4, 1.56, and 1.83 MeV, respectively, -0.5 ± 1.3, -3.9 ± 1.6, -4.2 ± 1.1, -6.8 ± 1.7, -11.7 ± 1.4, -13.1 ± 1.4, and -13.5 ± 1.2%. These results indicate that at deuteron energies as low as 0.3 MeV the d–t reaction has to be described by s-wave deuterons. (auth)

8935 SUM-RULE PHOTODISINTEGRATION CROSS SECTIONS FOR THE THREE-NUCLEON SYSTEM WITH THE HAMADA–JOHNSTON POTENTIAL. Lucas, C. (Univ. of New South Wales, Kensington). Nucl. Phys., A123: 173-85(1969).

A sum-rule calculation of the three-body photodisintegration cross sections (σ_{int} and σ_b) is performed using the Hamada-Johnston potential. This is the first calculation of the E1 transition with a realistic potential, and the results show the importance of the tensor force in obtaining agreement with experiment. The contributions of the parity dependent linear LS and quadratic LS forces are negligible. The quantity σ_b is closely related to the charge radius of ^3H and thus allows an estimation of the Coulomb energy. This estimation gives $E_C = 0.60 \pm 0.03$ MeV, which is in accordance with previous calculations. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 8463, 9010, 9027, 9029–9031, 9044, and 9056.

8936 (TID-24667, pp 464-73) PICK-UP REACTION IN THE INNER SHELL AND (p, px) REACTIONS AT 156 MeV. Radvanyi, Pierre (Paris Univ., Orsay (France). Institut de Physique Nucleaire).

The results of some (p,d) experiments on the pick-up of neutrons in the inner shell (the 1s shell for 1p nuclei and the 1p shell for 2s1d nuclei) are presented including data on the reactions $^{12}C(p,d)^{11}C$, $^4He(p,d)^3He$, $^6Li(p,d)^5Li$, and $^7Li(p,d)^6Li$. In addition, the results of some investigations of the reactions $^{12}C(p,pd)$, $^6Li(p,pd)$, and $^6Li(p,p^3He)$ are given. (D.C.W.)

8937 (TID–24667, pp 626-36) THE (π^+2p) REACTIONS ON NUCLEI. Charpak, G. (European Organization for Nuclear Research, Geneva (Switzerland)).

The results of an investigation of (π^+,2p) reactions on ^{27}Al, ^9Be, B, ^{40}Ca, ^{12}C, Cl, ^{19}F, ^4He, Fe, Pb, ^6Li, ^{14}N, ^{16}O, and S are presented. The observed excitation-energy and momentum distributions of the recoils are discussed, and some information on cross sections is included. (D.C.W.)

8938 INVESTIGATION OF (d,α) REACTIONS ON ^{19}F IN THE DEUTERON ENERGY REGION 2.4 TO 3.95 MeV. Zalyubovskii, I. I.; Lobkivskii, A. P.; Nemets, O. F.; Melenevskii, A. Z. (Kharkov State Univ.). Yadern. Fiz., 8: 663-7(Oct. 1968). (In Russian).

Excitation functions of the first three groups of α particles under the angle 150° were investigated as well as angular distributions at nine different energies. Analyzing experimental data, one obtains information on the mechanism of the reaction $^{19}F(d,\alpha)$ ^{17}O in the incident deuteron energy region 2.4 to 3.95 MeV (mainly, the mechanism of compound-nucleus production) as well as spectroscopic information on some levels of ^{21}Ne in the excitation energy region 19.56 to 20.97 MeV. The newly observed state with the energy 19.88 MeV has width $\Gamma \sim 200$ keV and spin $5/2^+$. (auth)

8939 ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM THE REACTION $^{16}O(\gamma,p)^{15}N$. Tutakin, P. M. (Physical-Technical Inst., Kiev). Yadern. Fiz., 8: 661-2(Oct. 1968). (In Russian).

Angular distributions of photoprotons from the reaction $^{16}O(\gamma,p)$ ^{15}N were measured by means of photoplates placed in H_2O and by means of monoenergetic γ rays from the reaction $T(p,\gamma)^4He$. The number of tracks of photoprotons observed under immersion angles $\beta \leq 30°$ for the intervals of emission angles θ of 0 to 15, 15 to 30, 30 to 45, 45 to 60, 60 to 75, and 75 to 90° were 305, 172, 89, 40, 25, and 33 (E_γ = 21.71 MeV) and 4, 18, 25, 33, 51, and 69 (E_γ = 22.16 MeV), respectively. The angular distributions obtained do not correspond to the angular distribution of γ rays for the inverse reaction $^{15}N(p,\gamma)^{16}O$ [$W_\gamma = 1 + 0.1P_1 - 0.6P_2$] (auth)

8940 CALCULATION OF THE CAPTURE OF NEGATIVE PIONS IN LIGHT ELEMENTS AND COMPARISON WITH EXPERIMENTS PERTAINING TO CANCER RADIOTHERAPY. Guthrie, M. P.; Alsmiller, R. G. Jr.; Bertini, H. W. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 66: 29-36(Dec. 1, 1968).

Reactions resulting from the capture of π^- mesons in carbon, nitrogen, oxygen, and aluminum have been studied using a Monte Carlo intranuclear-cascade model. The calculation predicts the multiplicities of the particles emitted following π^- capture and the residual nuclei remaining after the reaction. The energy distributions of the emitted particles and the residual nuclei have also been determined. The results of the calculation have been compared with experiments investigating the feasibility of the use of π^- mesons in cancer radiotherapy, and reasonable agreement has been obtained. (auth)

8941 CROSS SECTIONS OF THE $^{12}C(^3He,p)^{14}N$ REACTION. Matsuda, Kazuhisa; Nakanishi, Noriyoshi; Takeda, Sigeru; Wada, Takeshi (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap., 25: 1207-13(Nov. 1968).

Differential cross sections of the $^{12}C(^3He,p)^{14}N$ reaction were measured at an incident energy of 25.3 MeV. Angular distributions for individual levels showed patterns of the direct surface reaction. Contributions from overlapping peaks were resolved with a computer code. Strong peaks were found at the excitation energies of 9.0 MeV and near 13.0 MeV. These facts are in agreement with other cases of the proton-neutron transfer to ^{12}C. Comparisons between the reactions (^3He,p) and (α,d) are discussed. (auth)

8942 $^{11}B(\alpha,^7Li)^8Be$ REACTION AT 28.4 AND 29.0 MeV. Kakigi, Shigeru; Fujiwara, Noboru; Fukunaga, Kiyoji; Nguyen, Dai-Ca; Yamashita, Sukeaki; Yanabu, Takuji (Kyoto Univ.). J. Phys. Soc. Jap., 25: 1214-19(Nov. 1968).

^7Li ions from the $^{11}B(\alpha,^7Li)^8Be$ reaction were detected with a 50μ-thick solid-state detector covered with aluminum absorbers. The analyses suggest that the compound-nucleus process is not favorable to the $^{11}B(\alpha,^7Li)^8Be$(g.s.) reaction. The angular distributions of ^7Li(0.478 MeV state) can be reproduced by the calculation based on the triton pickup process.

The features of the angular distributions for ^{7}Li(g.s.) are quite different from that for ^{7}Li(0.478 MeV state) and are qualitatively explained by the triton pickup process and the ^{7}Li knockout process interfering with each other. (auth)

8943 MAGNETIC MOMENTS OF SHORT-LIVED β- RADIOACTIVE NUCLEI ^{12}B AND ^{12}N. Sugimoto, Kenzo; Nakai, Kozi, Matuda, Kozi; Minamisono, Tadanori (Osaka Univ.). J. Phys. Soc. Jap., 25: 1258-67(Nov. 1968).

The magnetic moments of ^{12}B($T_{\frac{1}{2}}$ = 20 ms) and ^{12}N($T_{\frac{1}{2}}$ = 11 ms) were determined by an NMR method using recoil polarization and asymmetric β decay. The nuclear polarization was preserved by using a static magnetic field and a recoil stopper of metal foil. Several kinds of metal foils were employed. Relative shifts of the order of 10^{-3} between the centers of NMR by different metals and resonance widths comparable to the dipolar broadening were observed. The results obtained for the magnetic moments are $\mu(^{12}B,1^{+}) = +1.003 \pm 0.001$ nm and $\mu(^{12}N,1^{+}) = +0.4571 \pm 0.0005$ nm. (auth)

8944 CROSS SECTIONS FOR THE ^{16}O(γ,2n), ^{19}F(γ,2pn), ^{27}Al(γ,2pn), ^{51}V(γ,α), AND ^{51}V(γ,α3n) REACTIONS TO 300 MeV. Meyer, Richard A.; Walters, William B.; Hummel, John P. (Univ. of Illinois, Urbana). Nucl. Phys., A122: 606-24(1968).

Yield and cross section results were obtained for some photonuclear reactions in ^{16}O, ^{19}F, ^{27}Al, and ^{51}V targets by measuring the radioactivities of the product nuclei in samples that were irradiated with bremsstrahlung in the 20 to 300 MeV energy range. The reactions studied were ^{16}O(γ,2n), ^{19}F(γ,2pn), ^{27}Al(γ,2pn), ^{51}V(γ,α), and ^{51}V(γ,α3n). The cross sections at energies above 150 MeV were interpreted in terms of the contributions from various reaction mechanisms. The reactions in O, F, and Al generally have important contributions from both quasi-deuteron and pion emission processes. In the ^{51}V reactions, the additional pion reabsorption mechanism also makes important contributions. The reaction cross sections at energies below 150 MeV were used to determine the total cross sections for photon absorption at energies above the giant-resonance region and below 150 MeV. The resulting total cross sections are generally consistent with those determined from neutron-counting experiments. (auth)

8945 A STUDY OF SOME ^{3}He-INDUCED REACTIONS ON ^{13}C AND THE STRUCTURE OF ^{16}O. Weller, H. R. (Duke Univ. Nuclear Structure Lab., Durham, N. C.); Roberson, N. R.; Tilley, D. R. Nucl. Phys., A122: 529-56(1968).

A study of angular distributions and excitation functions of several reactions produced by bombarding ^{13}C with ^{3}He ions with energies from 2.0 to 8.0 MeV indicates the importance of the structure of ^{16}O in this process. An optical-model analysis of the elastic scattering from ^{13}C provided the entrance channel parameters for a DWBA calculation of the (^{3}He, α) reaction. The results of this calculation indicate the inadequacy of this approach. An optical-model-plus-resonance analysis was also attempted for the elastic scattering of ^{3}He from both ^{12}C and ^{13}C to account for some observed anomalies. A statistical analysis of the ^{13}C(^{3}He,α)^{12}C data indicates that the assumption $\Gamma \gg D$ is a credible one, although at 6.0-MeV ^{3}He energy, a resonance in ^{16}O becomes apparent. A spin and parity assignment $J^{\pi} = 3^{-}$ is suggested for this new state in ^{16}O. The eigenchannel calculations of Wahsweiler, Danos, and Greiner predict a 3^{-}(T = 0) state in ^{16}O near this excitation energy. (auth)

8946 MUON CAPTURE IN ^{12}C AND NUCLEAR STRUCTURE. Hirooka, Masahiko (Osaka Univ.); Konishi, Teruaki; Morita, Reiko; Narumi, Hajime; Soga, Michitoshi; Morita, Masato. Progr. Theor. Phys. (Kyoto), 40: 808-29(Oct. 1968).

The muon capture rate for $^{12}C + \mu^{-} \rightarrow {}^{12}B$ (ground state) + ν was calculated using general p-shell wave functions which were obtained by considering the dynamical properties in the A = 12 system. The theoretical formula for the capture rate is of such a form that the effect of the finite size of the nucleus on the muon wave functions is easily taken into account. The experimental ft value of ^{12}B, which in all previous theories is used to normalize the muon capture rate, has not been adopted in the analysis. An excellent fit to the experimental data for the capture rate as well as for the ft value was obtained with the ^{12}B wave function proposed by Kurath to explain the magnetic moment of ^{12}B and a ^{12}C wave function. These wave functions have slightly different values of configuration mixing parameters from those originally given by Cohen and Kurath. The value for the oscillator strength parameter used is b = 1.64 f; this is in conformity with the elastic and most of the inelastic electron scattering data. On the other hand, should b be taken as 1.90 f, the value derived from the analysis of the inelastic electron scattering data associated with the 15.1 MeV level in ^{12}C, it is relatively difficult to have a simultaneous fit to the data for the capture rate and the ft value. Results are based on the assumptions of universality of the V-A interaction in muon capture and beta decay, the validity of the conserved vector current theory, and the induced pseudoscalar coupling constant estimated by Goldberger and Treiman. (auth)

8947 ON THE CAPTURE OF NEGATIVE PIONS BY ^{6}Li. Alberi, G.; Taffara, L. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim., 58B: 441-52(Dec. 11, 1968).

The absorption at rest of negative pions by ^{6}Li is investigated. A simple alpha-deuteron model for ^{6}Li is assumed and a pole-diagram approximation is used to calculate the capture rates. The agreement with recent experimental data is satisfactory. (auth)

8948 RADIATIVE CAPTURE OF PROTONS BY ^{11}B ABOVE THE PEAK OF THE GIANT DIPOLE RESONANCE. Kernel, G.; Mason, W. M. (Oxford Univ.). Nucl. Phys., A123: 205-14(1969).

The radiative capture of protons by ^{11}B was investigated for proton energies between 14 and 21 MeV. The excitation functions and angular distributions for the gamma rays to the ground and first excited state were measured. In both cases the angular distributions show a typical forward peaking. (auth)

8949 THERMAL NEUTRON CAPTURE IN ^{19}F. Hardell, R.; Hasselgren, A. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys., A123: 215-24(1969).

Gamma rays from thermal neutron capture in fluorine were measured with Ge(Li) spectrometers. About 50 of the 80 lines observed have been tentatively fitted into the ^{20}F decay scheme. New energy values of several ^{20}F levels were determined, and the spin assignments of some low-lying levels are discussed. (auth)

8950 DWBA ANALYSIS OF ^{6}Li(p,d)^{5}Li AND ^{7}Li(p,d)^{6}Li REACTIONS AT 100 MeV. Li, T. Y.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys., A123: 147-60(1969).

The ^{6}Li(p,d)^{5}Li and ^{7}Li(p,d)^{6}Li reactions at 100 MeV were analyzed by the use of the conventional DWBA theory with local-energy approximation. Reasonably good agreement with the experimental data was obtained. The deuteron distorted waves were obtained by optimizing the optical potential parameters to fit the angular distribution of the ground-state transition. The excited state transitions were analyzed with all potential parameters fixed. Absolute spectroscopic factors extracted from experiment are in very good agreement with those predicted by the intermediate-coupling shell-model calculations. (auth)

8951 LOW-Q (d,n) STRIPPING REACTIONS ON ^{10}B, ^{12}C, AND ^{13}C. Chudleigh, P. W.; Gowers, C. K.; Muirhead, E. G. (Univ. of Melbourne). Nucl. Phys., A123: 114-28(1969).

Differential cross sections are presented for the low-Q transitions ^{10}B(d,n_0)^{11*}C (6.49 MeV); ^{12}C(d,n_0)^{13}N and ^{13}C(d,n_0)^{14*}N (4.91 MeV). Neutrons were detected by time-of-flight techniques, and the absolute cross sections for reactions (i) and (iii) were estimated from measurements of the absolute efficiency of the neutron detector. Because the neutron energies are very low in reaction (ii), the cross section was calculated from absolute measurements of the position activity of the residual ^{13}N nuclei. Theoretical fits were attempted using Butler plane-wave Born approximation, Coulomb stripping theory of Morinigo, and distorted-wave Born approximation (DWBA). Acceptable fits to all three reactions could only be achieved with the DWBA, thus indicating the importance of the nuclear distortion of the deuteron and neutron waves. The DWBA fits were rather critical with respect to the optical model and radial cut-off parameters with slight variations in these impairing the quality of the fits. Reactions (i) and (iii) exhabited the characteristic stripping patterns, while reaction (ii) exhabited a backward peaking interfering with the forward stripping peak. The optical-model parameters for all three reactions are summarized. Best fits to reactions (i) and (ii) were obtained with a cut-off radius which varied slowly with energy, but reaction (iii) favored the non-cut-off theory. (auth)

8952 THE g-FACTOR OF THE FIRST EXCITED STATE IN ^{19}Ne. Bleck, J.; Haag, D. W.; Leitz, W.; Michaelsen, R.; Ribbe, W.; Sichelschmidt, F. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A123: 65-80(1969).

The first two excited states of ^{19}Ne were populated by the reaction ^{19}F(p,n), and the de-excitation γ-rays were detected. The half-lives $T_{\frac{1}{2}}$ were remeasured. The gamma yield was observed in a proton energy range from 4.4 MeV to 6.1 MeV. The g-factor of the $\frac{1}{2}^{+}$ level was determined by the pulsed-beam DDCA method. The results are $T_{\frac{1}{2}} = 17.7 \pm 0.7$ ns, $g = -0.296 \pm 0.003$ for the $\frac{1}{2}^{+}$ 238-keV state and $T_{\frac{1}{2}} < 0.3$ ns for the $\frac{1}{2}^{-}$ 275-keV state. The g-factor is compared with values predicted by various models. The mirror theorem of Sachs is applied. (auth)

8953 RESONANCES IN THE REACTION $^{10}B + \alpha$ BY THE STUDY OF γ RAYS DETECTED WITH A Ge(Li) SEMICONDUCTOR. Gallmann, A.; Hibou, F.; Fintz, P. (Institut de Recherches

Nucleaires, Strasbourg). Nucl. Phys., A123: 27-32(1969). (In French).

A Ge(Li) detector was used to study gamma rays from the $^{10}B(\alpha,p\gamma)^{13}C$ and $^{10}B(\alpha,\alpha'\gamma)^{10}B$ reactions. Relative cross sections for the 3.088-, 3.682-, 3.852-, and 0.717-MeV gamma rays were obtained, and excitation curves at 90° for α particles with energies from 1 to 3.5 MeV are given corresponding to excited levels between 12.3 and 14.1 MeV in ^{14}N. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 7758, 7776, 7906, 8463, 8902, 8937, 8938, 8940, 8944, 8949, 8974, 9002, 9010, 9029, 9030, and 9055.

8954 (AECL-3073) THERMAL NEUTRON ABSORPTION CROSS SECTIONS OF ZIRCALOY-2, COPPER, AND ALUMINUM. Okazaki, A.; Green, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr. 1968. 20p. Dep. CFSTI. CAN $1.00.

The 2200 m/s absorption cross sections of Zircaloy-2, Cu, and Al were determined relative to that of gold by measuring the relative reactivity effects of samples placed in a well-moderated region of the ZED-2 reactor. The following results were obtained: σ_0 (Zircaloy-2) = 0.208 ± 0.002 barns; σ_0 (Cu) = 3.71 ± 0.06 barns; and σ_0 (Al) = 0.234 ± 0.005 barns, assuming σ_0 (Au) = 98.8 barns. These are in agreement with those of other workers. A discussion of the variations in the cross section of Zircaloy-2 samples due to differences in composition is presented. (auth)

8955 (PEL-180) HIGH-RESOLUTION FAST NEUTRON CROSS SECTIONS OF IRON. Barnard, E.; De Villiers, J. A. M.; Engelbrecht, C. A.; Reitmann, D.; Smith, A. B. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). July 1968. 35p. Dep.

The interactions between Fe and neutrons with energies between 0.3 and 1.5 MeV were studied using time-of-flight methods. Particularly, the total and inelastic scattering cross sections were determined with good energy resolution; and a considerable amount of structure was observed. The results were investigated in terms of various theoretical approaches. (auth)

8956 (TID-24667, pp 137-45) CHARGE DISTRIBUTIONS FROM ELASTIC SCATTERING. Ravenhall, D. G. (Illinois Univ., Urbana. Dept. of Physics).

The analysis of some electron elastic scattering data on Ca isotopes to extract a phenomenological charge density is described, and some properties of the charge density are examined. The combination of electron scattering data and μ-mesic x-ray data to obtain more detailed information is discussed using measurements on ^{208}Pb as an example. (D.C.W.)

8957 ELASTIC AND INELASTIC HIGH ENERGY ELECTRON SCATTERING ON NUCLEI ^{28}Si. Savitskii, G. A.; Afanas'ev, N. G.; Gul'karov, I. S.; Kovalev, V. D.; Omelaenko, A. S.; Khvastunov, V. M.; Shevchenko, N. G. Yadern. Fiz., 8: 648-60(Oct. 1968). (In Russian).

Differential cross sections of elastic and inelastic electron scattering on natural silicon were measured in the energy region 110 to 260 MeV and in the scattering angle interval 30 to 130°. Parameters of the charge distribution in the ground state were obtained using the "Gauss homogenous model" and the modified Born approximation: R = 3.38 fermi and g = 0.91 fermi. The data on the inelastic scattering with the excitation of the levels 1.78, 4.62, 6.9 ± 0.2, and 9.7 ± 0.1 MeV were analyzed in the modified Born approximation for some models of charge density distribution. The deformation parameter of ^{28}Si nucleus, intrinsic quadrupole moment, reduced probabilities of transitions, oscillation parameters B_λ and C_λ, etc., were determined. In the cases when it was possible, the parameters obtained were compared with existing experimental data. (auth)

8958 EXCITATION OF MULTIPOLE COLLECTIVE STATES OF THE Ni AND Zn ISOTOPES AND THEIR ANALYSIS ON BASIS OF THE COMPLEX ANGULAR MOMENTA METHOD. Gonchar, V. Yu.; Zheltonog, K. S.; Ivanov, G. N.; Yushkov, A. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 8: 678-87 (Oct. 1968). (In Russian).

Inelastic scattering of 40-MeV α particles on the nuclei $^{58,64}Ni$ and $^{64,68}Zn$ with excitation of the 2^+ and 3^- collective states was studied experimentally. Because of the fact that the effects in view are small, special attention was paid to the identity of experimental conditions for all four nuclei. Experimental results were analyzed in terms of the theory of the α-particle inelastic diffraction scattering on a strongly absorbing nucleus with diffuse edge. Nuclear matrix elements $|C(l)|$ and the parameters of multipole deformation β_l were determined. Isobar and isotopic effects were estimated. (auth)

8959 REACTIONS $^{58\ 60\ 62\ 64}Ni(d,n)^{59\ 61\ 63\ 65}Cu$ AND $^{64\ 66\ 68}Zn(d,n)^{65\ 67\ 69}Ga$. Okorokov, V. V.; Bochin, V. P.; Romanov, V. S.; Serezhin, V. M.; Smotryaev, V. A.; Tolchenkov, D. L.; Trostin, I. S.; Cheblukov, Yu. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 668-77 (Oct. 1968). (In Russian).

Proton states of nuclei $^{59,61,63,65}Cu$ and $^{65,67,69}Ga$ excited as a result of reactions $^{58,60,62,64}Ni(d,n)^{59,61,63,65}Cu$ and $^{64,66,68}Zn(d,n)^{65,67,69}Ga$ were investigated. The neutron spectra were measured by the time-of-flight method. For allowed levels the orbital momentum of the captured proton and the value of the one-particle transition strength $(2j + 1)C^2S$ were determined by means of the distorted-wave approach. (auth)

8960 PRECISION MEASUREMENTS OF GAMMA RAYS FROM ^{60}Co, ^{41}Ar, AND $^{53}Cr(n,\gamma)^{54}Cr$. White, D. H.; Groves, D. J.; Birkett, R. E. (Univ. of California, Livermore). Nucl. Instrum. Methods, 66: 70-6(Dec. 1, 1968).

The energies of the ^{60}Co and ^{41}Ar γ-rays were measured with a Ge(Li) detector to be 1173.23 ± 0.04, 1332.54 ± 0.04 and 1293.64 ± 0.04 keV, respectively. The limit of validity of the second-escape peak method is discussed in terms of the comparison of the ^{60}Co results with other measurements. The method was used to determine the prominent γ rays from the $^{53}Cr(n,\gamma)^{54}Cr$ reaction spanning the region 1 to 10 MeV. The neutron binding energy of ^{54}Cr was found to be 9719.77 ± 0.65 keV. (auth)

8961 EXCITATION OF THE 0.85-MeV LEVEL OF ^{56}Fe BY 14-MeV NEUTRONS. Voignier, Jacques (CEA, Villeneuve-Saint-Georges, France). Compt. Rend., Ser. A and B, 267: 733-5(Oct. 7, 1968). (In French).

The excitation of the 2^+ 0.85-MeV level of ^{56}Fe was observed by the inelastic scattering of 14-MeV neutrons. The excitation cross section was evaluated as 64 ± 13 mbarns. The important quadrupole excitation probability observed for this level reveals a sharply collective character. (tr-auth)

8962 DETERMINATION OF THE BRANCHING RATIO AND THE SPIN OF THE LEVEL AT 3614 keV IN ^{41}Ca OBSERVED IN THE (d,pγ) REACTION ON ^{40}Ca. Schapira, Jean-Paul; Johnson, Galway; Blake, Robert (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 267: 832-5(Oct. 14, 1968). (In French).

The reaction $^{40}Ca(d,p\gamma)^{41}Ca$ leading to the level at 3614 keV of the residual nucleus was studied at E_d = 4 MeV. The branching ratio of this level was determined, and a new transition to the ground state was observed. The p-γ angular correlation on the ray at 3614 keV, together with previous results, indicates a spin $J^\pi = 3/2^-$. Quantitative arguments indicate that this level is probably the principal component at 3p-2t predicted by Gerace and Green in ^{41}Ca. (tr-auth)

8963 PHOTOPROTON SPECTRUM FROM ^{19}F. Abe, Ken; Tanaka, Eiji; Kawamura, Nobuaki; Kanazawa, Masaaki; Mutsuro, Naoshi (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 25: 1507 (Nov. 1968).

The energy spectrum of photoproton from ^{19}F produced by 22-MeV bremsstrahlung was studied using a TMC silicon detector. Distinct peaks were found at 7.15 and 8.3 MeV. (J.W.R.)

8964 NUCLEAR DATA SHEETS. Nucl. Data, Sect. B, 2: B2.6.1-B2.6.136(Oct. 1968).

Information on the decay schemes and level schemes of A = 65 through 69 nuclei is presented, together with appropriate reaction data. Adjusted mass differences for A = 65 to 69 nuclei are also included, together with decay and separation energies. (D.C.W.)

8965 SPINS AND GAMMA DECAY OF EXCITED STATES IN ^{26}Si. Rolfs, C.; Trost, W. (Univ., Freiburg i. B.). Nucl. Phys., A122: 633-44(1968).

Excited states of ^{26}Si were found at 1.79 ± 0.01, 2.78 ± 0.01, 3.32 ± 0.02, 3.82 ± 0.04, and 4.13 ± 0.03 MeV from the reaction $^{24}Mg(^3He, n\gamma)^{26}Si$; the last state is possibly a multiplet. The spins of these states were determined as 2, 2, (0), 3 and (2), respectively, from n-γ correlation measurements. The branching ratios and some mixing ratios are reported. The ^{26}Si level scheme is compared with those of ^{26}Mg and ^{26}Al. (auth)

8966 THE $^{64}Zn(p,p')^{64}Zn$ AND $^{64}Zn(p,d)^{63}Zn$ REACTIONS AT 26 MeV. Johnson, R. R.; Jones, G. D. (Univ. of Colorado, Boulder). Nucl. Phys., A122: 657-66(1968).

Elastic and inelastic scattering measurements with 26.0 MeV protons on ^{64}Zn were performed. Angular distributions for nine of the 22 observed levels were compared to distorted-wave calculations using collective-model form factors. Angular distributions

for 21 deuteron peaks were obtained and compared to distorted-wave calculations using non-local and finite-range corrections. (auth)

8967 NEUTRON ACTIVATION CROSS SECTIONS AT 14.4 MeV FOR Si AND Zn ISOTOPES. Ranakumar, N.; Kondaiah, E.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys., A122: 679-83(1968).

Pure Si powder was used to compare the cross section for the $^{28}Si(n, p)^{28}Al(2.238\ min)$ reaction with that of the $^{56}Fe(n, p)^{56}Mn$ reaction. In the case of $^{30}Si(n, p)^{30m}Al$ (72.5 sec), previously reported gammas were not found; an upper limit of 7 mb is obtained for this cross section. The cross section for $^{70}Zn(n, 2n)^{69m}Zn$ is reported. Three (n, 2n), six (n, p), and two (n, α) cross sections for Si and Zn isotopes were measured by using the method of mixed powders and Ge(Li) gamma detection. (auth)

8968 CONVERSION COEFFICIENTS OF ^{86m}Rb. Schmidt-Ott, W.-D. (Univ., Goettingen, Ger.). Z. Phys., 219: 70-4(1969). (In German).

^{86m}Rb was produced by irradiation of natural Rb and Rb enriched in ^{87}Rb (99.2%) with fast neutrons. The half-life of $T_{\frac{1}{2}} = 61.2 \pm 1.0$ sec and the energy of $E_\gamma = 556.03 \pm 0.25$ keV were remeasured. The experimental conversion coefficients $\alpha_{tot} = 0.0184 \pm 0.0015$ and $\alpha_K = 0.0158 \pm 0.0015$ yield the multipolarity of E4 for the isomeric transition. The spin of 6^- was assigned to the isomeric state. It is proposed that the spin 6^- is formed by coupling a $p_{\frac{1}{2}}$-proton and a $g_{\frac{9}{2}}$-neutron according to Nordheim's "weak" rule. (auth)

8969 STUDY OF THE AVERAGE LEVEL SPACING FROM NEUTRON-CAPTURE CROSS SECTIONS. Hasan, S. S.; Chaubey, A. K.; Sehgal, M. L. (Aligarh Muslim Univ., India). Nuovo Cim., 58B: 402-6(Dec. 11, 1968).

Neutron activation cross sections were measured for 19 cases at 24 keV. A Sb–Be photoneutron source was used for these measurements. The value of the average level spacing D was estimated for these cases using the statistical theory of nuclear reactions. These estimated values of average level spacing were compared with the experimental values wherever they are known from low-energy resonance parameter data. Agreement between these two sets of values is found. (auth)

8670 SHELL-MODEL CALCULATIONS ON A = 38 NUCLEI. Engelbertink, G. A. P.; Glaudemans, P. W. M. (Rijksuniversiteit, Utrecht). Nucl. Phys., A123: 225-40(1969).

The shell model is used to investigate properties of levels in the A = 38 nuclei. An inert ^{28}Si core with a residual two-particle interaction between the outer nucleons is assumed. The negative-parity states are described by a closed $2s_{\frac{1}{2}}$ shell, five nucleons in the $1d_{\frac{3}{2}}$ shell and one nucleon in the $1f_{\frac{7}{2}}$ or $2p_{\frac{3}{2}}$ shell. For the positive-parity states, all configurations in the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ shell are taken into account. The effective two-particle interaction is chosen to be a modified surface delta interaction. The four parameters of this effective interaction are determined in a least-squares fit to the excitation energies of 15 nuclear levels. The rms deviation of the calculated energies from the experimental energies is 0.28 MeV. From the values of these parameters, the energies and wave functions of about 50 levels are derived. The wave functions are used to determine γ-ray branching ratios, mean lives, ft values in allowed β-decay and spectroscopic factors for the $^{37}Cl(d,p)^{38}Cl$ reaction. The computed branching ratios, mean lives, and ft values agree generally within a factor of 2.5 with the experimental values. Good agreement with experiment is obtained for the spectroscopic factors. (auth)

8971 SEVERAL NARROW RESONANCES IN THE PROTON BOMBARDMENT OF ^{20}Ne. Bloch, R.; Knellwolf, T.; Pixley, R. E. (Univ., Zurich). Nucl. Phys., A123: 129-46(1969).

States in ^{21}Na at 3.544, 3.680, 3.864 and 4.293 MeV were studied by proton elastic scattering and radiative capture in ^{20}Ne. The properties of these states are compared with the corresponding states in ^{21}Ne and with the predictions of the Nilsson model. (auth)

8972 COLLECTIVE 2^+ AND 3^- EXCITATIONS IN Ni AND Zn ISOTOPES VIA INELASTIC DEUTERON SCATTERING. Jolly, R. K.; Goldberg, M. D.; Sengupta, A. K. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A123: 54-64 (1969).

Excitation energies and differential cross sections for inelastic scattering of 11.5 or 11.8 MeV deuterons leading to the collective 2^+ and 3^- states of ^{64,62,60,58}Ni and ^{68,66,64}Zn were measured. The cross sections were compared with distorted-wave Born approximation calculations for a deformable potential using complex coupling and including the contribution from Coulomb excitation. Effects of using different exit and entrance channel optical-model parameters on the cross sections for the 3^- states are discussed. In addition to spin and parity assignments, values of B(E2) and B(E3) were extracted. In all cases studied in the present work, DWBA calculations yield values of B(E2; $0 \rightarrow 2$) in good agreement with previous measurements if the interaction radius is chosen to be the radius of the real well. (auth)

8973 POSSIBLE DOORWAY-STATE STRUCTURE IN THE SCATTERING OF NEUTRONS BY Fe. Elwyn, A. J.; Monahan, J. E. (Argonne National Lab., Ill.). Nucl. Phys., A123: 33-53(1969).

An analysis of 150-keV-wide structure observed in the scattering of neutrons by Fe at energies between 0.35 and 0.96 MeV is based on the doorway-state interpretation of such structure. The methods of analysis are presented in some detail. The distribution of compound-nucleus widths and spacings as well as the measured differential cross sections and polarizations are shown to be reasonably consistent with predictions that result from the doorway-state hypothesis. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 7758, 7776, 8450, 8463, 8926, 8937, 8954, 8956, 8969, 9009, 9012, 9014, 9042, 9043, 9053, 9055, and 9062.

8974 (BNL-tr-240) CROSS SECTIONS FOR THE RADIATIVE CAPTURE OF FAST NEUTRONS BY ^{74}Ge, ^{133}Cs, AND ^{192}Os. Tolstikov, V. A.; Koroleva, V. P.; Kolesov, V. E.; Dovbenko, A. G. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 23: 576-80(1967). 10p. Dep. CFSTI.

The cross sections for the radiative capture of 0.2- to 3-MeV neutrons by ^{133}Cs, ^{74}Ge, and ^{192}Os were measured using end-window β counters to register the induced activities. The reaction T(p,n) ^{3}He was used as the neutron source, and a ^{235}U fission chamber was used to monitor the neutron flux. (D.C.W.)

8975 (JINR-P3-4110) ON THE KINETIC ENERGY VARIATION OF THE FRAGMENTS OF ^{235}U FISSION BY 0.006- TO 20-eV NEUTRONS. Bochvarov, S.; Dermendzhiev, E.; Kashukeev, N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 29p. (In Russian). Dep.

The kinetic energy variation was studied for the thermal range and for the resonances of ^{235}U by the method of measuring the relative yield of W fragments from two targets of different thickness using the neutron spectrometer of the Neutron Physics Laboratory (JINR) in the energy range 0.006 to 20 eV. It was found that the resonances at 0.29, 2.04, 3.14, 4.84, and 7.09 eV can be separated into the group with smaller values of W and, respectively, E_k, while resonances at 1.14, 3.60, 6.40, 8.78, 12.4, and 19.3 eV form the group with larger W and E_k. The comparison of the values with the radiochemical data on the fission fragment yield in the thermal range and in ^{235}U resonances shows that, evidently, E_k is larger in more asymmetric fission. From the values $\overline{W}(I)$ and $\overline{W}(II)$ for two resonance groups, the variation of the average total kinetic energy of the fragments was found to be $2\ \Delta\overline{E} = 0.74 \pm 0.32$ MeV. (auth)

8976 (JINR-P6-4079) INVESTIGATION OF THE ^{211}At, ^{211}Po, ^{210}At, ^{209}At, AND ^{207}At α SPECTRA WITH SEMICONDUCTOR α SPECTROMETER. Gueth, L.; Gueth, S.; Daroczy, E.; Dzhelepov, B. S.; Norseev, Yu. V; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 13p. (In Russian). Dep.

The α decay of the $^{211-209}$At, ^{207}At, and ^{211}Po isotopes was investigated. The energies and intensities of the α lines were measured. The probability of the ^{211}At and ^{209}At α decay and the half-life of ^{210}At, ^{209}At, and ^{207}At were determined. (auth)

8977 MASS DISTRIBUTION OF FRAGMENTS AT FISSION OF THE Bi AND U NUCLEI BY HEAVY IONS. Karamyan, S. A.; Normuratov, F.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Pustyl'nik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 690-4(Oct. 1968). (In Russian).

Mass distributions of the fission fragments in the reactions $^{238}U(^{20}Ne,f)$, $^{238}U(^{40}Ar,f)$, and $^{209}Bi(^{20}Ne,f)$ were measured. Isotopes obtained in these reactions were identified by a γ spectroscopic method using a semiconductor Ge(Li) spectrometer with high energy resolution. The mass distribution became much broader as the excitation energy and Z^2/A of the fission nucleus increased. The strong broadening of the mass distribution occurs at $Z^2/A > 38$. The mass distribution width parameter σ^2 increases with the excitation energy more sharply than $\sigma^2 \sim T$. The charge distribution constant C also increases with the excitation energy but more weakly than σ^2. (auth)

8978 E2 CORE POLARIZATION BY THE $h_{\frac{9}{2}}$ PROTON. Ishihara, M.; Gono, Y.; Ishii, K.; Sakai, M.; Yamazaki, T. (Tokyo Univ.). Phys. Rev. Lett., 21: 1814-16(Dec. 30, 1968).

The half-life of the 8^+ state of ^{210}Po was measured. An effective charge of (1.68 ± 0.09)e (including proton charge) for the $h_{9/2}$ proton orbit was deduced from the analysis of the three experimental B(E2) values with use of the radial integral for a Saxon–Woods potential. (auth)

8979 ON THE DECAY SCHEME OF ^{159}Er. Abdurazakov, A. A.; Gromov, K. Ya.; Zhelev, Zh. T.; Kalinnikov, V. G.; Liptak, Ya.; Nazarov, U. K.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 633-8(Oct. 1968). (In Russian).

Gamma-ray, conversion electron, and positron spectra from ^{159}Er were investigated. New γ transitions with the energies 270, 294.1, and 341.6 keV were found. New levels in the ^{159}Er decay scheme with the energies 160.3(2^-), 408.9(1^+), and 425.6 keV (1^-) are presented. Multipolarities of the transitions 386.9, 358.3, and 341.6 keV were determined. Multipolarities of some other γ transitions were estimated. Quantum parameters for the levels with the energies 67.2 (2^-) and 454.2 keV (1^-) were established. The mass difference of the nuclei ^{159}Er and ^{159}Ho is determined to be 1860 ± 60 keV. The decay scheme of the nuclei ^{159}Er is discussed. (auth)

8980 RADIOCHEMICAL INVESTIGATION OF THE ^{229}Th FISSION BY SLOW NEUTRONS. Borisova, N. I.; Zenkova, R. A.; Kurchatov, B. V.; Morozov, L. N.; Novgorodtseva, V. I.; Pchelin, V. A.; Chistyakov, L. V.; Shubko, V. M. Yadern. Fiz., 8: 695-703(Oct. 1968). (In Russian).

Yields of 46 isotopes among the ^{229}Th fission products are determined. Besides the two maxima of the asymmetric fission, a third one is observed which corresponds to symmetric fission. Fine structure is observed in the region of heavy fragments with the maxima at A = 134, 140, and 144. (auth)

8981 NEUTRON RESONANCES OF Nd ISOTOPES. Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B.; Taskaev, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 639-47(Oct. 1968). (In Russian).

The penetration and yield of γ rays from neutron capture were measured for samples with natural Nd and for samples enriched by the isotopes $^{142, 143, 144, 145, 146, 148, 150}$Nd. The neutron spectrometer of LNP (JINR) with the resolution from 80 up to 6 nsec/m was used. The isotopes ^{143}Nd and ^{145}Nd were investigated for the energies up to 1000 eV, other isotopes were investigated up to 10 keV. The following distances between the levels are obtained for the isotopes $^{142, 143, 144, 145, 146, 148, 150}$Nd, respectively: 1000 ± 250, 38 ± 6, 520 ± 70, 20 ± 3, 310 ± 43, 200 ± 21, and 230 ± 28 eV. The following values of the strength function S_0 are also obtained: 0.6 ± 0.3 × 10^{-4}, 4.3 ± 1.4 × 10^{-4}, 4.8 ± 2.0 × 10^{-4}, 3.0 ± 0.7 × 10^{-4}, 4.5 ± 4.9 × 10^{-4}, 3.6 ± 1.1 × 10^{-4}, and 2.0 ± 0.8 × 10^{-4}. (auth)

8982 NATURE OF THE TRANSITIONS AT 103.2 keV IN ^{116}Sb AND AT 134.5 keV IN ^{116}Sn. Rahmouni, Omar (Institut d'Etudes Nucleaires, Alger, Algeria). Compt. Rend., Ser. A and B, 267: 736-8(Oct. 7, 1968). (In French).

The conversion electrons of the low-energy transitions were observed with the aid of a semi-circular magnetic spectrometer. The 103.2-keV transition in ^{116}Sb is an electric transition E1. The value of the conversion coefficient of the M1 transition of 134.5-keV in ^{116}Sn is made more precise. (tr-auth)

8983 β STARS AND MIXED (α, β) MULTIPLE STARS. Naumescu, M.; Iacomi, R. Bul. Stiint. Inst. Constr. Bucuresti, No. 17, 309-16(1966). (In Rumanian).

The number of processes leading to the occurrence of multiple stars from β or β and α disintegrations of the uranium family in nuclear emulsions is calculated and is plotted in terms of time. (auth) (Rom. Sci. Abstr.)

8984 DETERMINATION OF RATE CONSTANT OF ^{238}U SPONTANEOUS FISSION BY ACCUMULATION OF Xe ISOTOPES IN URANIUM MINERALS. Shukolyukov, Yu. A.; Ashkinadze, G. Sh. At. Energ. (USSR), 25: 428-9(Nov. 1968). (In Russian).

Published data on the rate of spontaneous fission of ^{238}U varies from 5.33 × 10^{-17} to 11.7 × 10^{-17} $year^{-1}$. An attempt was made to determine the rate constant of the spontaneous fission of ^{238}U on the basis of the stable xenon isotope concentration in uranium minerals. Uranium concentration was determined using isotopic dilution mass spectrometric methods with a ^{235}U-enriched mixture of isotopes as tracer. The same method with ^{128}Xe tracer was used for determining xenon concentration in minerals. Tabulated data for seven uranium-bearing minerals revealed the mean rate constant of ^{238}U spontaneous fission equal to (10.3 ± 0.5) × 10^{-17} $years^{-1}$. (R.V.J.)

8985 THERMAL-NEUTRON ACTIVATION CROSS SECTIONS AND RESONANCE INTEGRALS FOR ^{128}Te(n,γ)^{129g}Te AND ^{128}Te(n,γ)^{129m}Te. Maxia, Vera; Orvini, Edoardo; Rollier, Mario A. (Univ. of Pavia, Italy). Nucl. Sci. Eng., 35: 88-90(Jan. 1969).

The thermal neutron capture cross sections for the reactions ^{128}Te(n,γ)^{129g}Te and ^{128}Te(n,γ)^{129m}Te were measured by a neutron activation method, using gold as a standard. Samples of powdered tellurium enriched to 96.5% in ^{128}Te were measured by gamma spectrometry. The found values are 199.7 ± 8 and 16.1 ± 0.7 mb, respectively. The resonance integrals were calculated by irradiating tellurium and gold, or cobalt, with and without cadmium covers; their values are 1.48 ± 0.13 b and 77.4 ± 5.2 mb, respectively. (auth)

8986 g-FACTOR OF THE FIRST EXCITED STATE IN ^{106}Pd. Johansson, K.; Norlin, L. O.; Carlsson, G. (Inst. of Physics, Uppsala). Ark. Fys., 37: 445-51(1968).

The g-factor of the first 2^+ excited level in ^{106}Pd was determined by perturbing the angular correlation of the 623 – 512 keV γ–γ cascade in an external field of 51.1 kG. The measurement was performed with Pd embedded in stainless steel, and the result for the g-factor is g = 0.40 ± 0.03. (auth) (Sweden)

8987 ANOMALOUS INTERNAL CONVERSION OF THE 212-keV TRANSITION IN ^{121}Te. Marelius, A.; Pettersson, H.; Toernkvist, S.; Haegglund, S. E.; Dumitrescu, R. (Univ. of Uppsala). Ark. Fys., 37: 435-43(1968).

The K-conversion probability of the 212-keV $d_{5/2} \rightarrow s_{1/2}$ transition in ^{121}Te was measured from K-Auger coincidences and from relative conversion intensities. The results are 7.70 ± 0.15 × 10^{-2} and 7.62 ± 0.22 × 10^{-2}, respectively. The 82K–212 γ and 82L–212 γ directional correlations were measured. The K-conversion coefficient of the 212-keV transition gives an E2 admixture which is consistent with that derived from L-subshell ratios and directional correlations only if dynamic nuclear structure effect are assumed in the M1 conversion process. With an E2 admixture of 5.5 ± 0.8%, the ratio between the penetration matrix element and the M1 gamma transition matrix element becomes λ = – 7 ± 1. (auth) (Sweden)

8988 LIFETIME OF 1.6-keV LEVEL IN ^{193}Pt MEASURED IN DIFFERENT CHEMICAL ENVIRONMENTS. Marelius, A. (Univ. of Uppsala). Ark. Fys., 37: 427-33(1968).

The lifetimes of the 1.64- and 14.3-keV levels in ^{193}Pt were measured with the delayed coincidence techniques in an electron-electron coincidence spectrometer. The results were 9.7 ± 0.3 and 2.52 ± 0.05 nsec, respectively. The influence of the chemical environment on the decay rate of the 1.64-keV level was measured in metallic and chloride sources revealing a (4 ± 2) percent longer half-life in the latter. (auth) (Sweden)

8989 EXPERIMENTAL DETERMINATION OF THE NUCLEAR MATRIX ELEMENTS OF THE $\beta(1^- \rightarrow 2^+)$ TRANSITION OF ^{170}Tm TO ^{170}Yb. Andre, Stephane; Liaud, Pierre; Millies-Lacroix, Jean-Claude (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 267: 836-9(Oct. 14, 1968). (In French).

The four matrix elements of the $1^- \rightarrow 2^+$ transition of ^{170}Tm were determined from measurements of the form of the spectrum and of the β-γ directional correlation. The ratio of the elements $\int i\vec{\alpha}$ and $\int \vec{r}$, which is in disagreement with the expression of Fujita, can be correctly interpreted by the Nilsson model. But this model does not seem able to take account of the individual magnitude of the matrix elements. (tr-auth)

8990 SURFACE DELTA INTERACTION IN HEAVY DEFORMED NUCLEI. Faessler, Amand (Univ., Muenster, Ger.). Fortschr. Phys., 16: 309-23(1968).

An attempt was made to simulate the realistic nucleon-nucleon interaction in heavy deformed nuclei by a simple force. It was shown that the interaction between nucleons in nucleus is mainly a surface phenomenon due to the specific behavior of the S-phase shifts. Accordingly, the surface delta interaction was adopted; and the only parameter of the surface delta interaction was derived in a self-consistent manner. The constant obtained gives the pairing part of the force in good agreement with the fits of the odd-even mass differences. The vibrational states and transition probabilities for rare-earth nuclei were calculated using the surface delta interaction. The results are in as good agreement with experimental data as are calculations by models with more parameters. (D.C.W.)

8991 IZOBARNYE YADRA S MASSOVYM CHISLOM A = 182. (Isobaric Nuclei With Mass Number A = 182). Vlonova, N. A.; Dzhelepov, B. S. Svoistva Atomnykh Yader. Vypusk 8. Leningrad, Izdatel'stvo Nauka, 1968. 328p.

A monograph dealing with investigations of the properties of ^{182}Hf, ^{182}Ir, ^{182}Os, ^{182}Pt, ^{182}Re, ^{182}Ta, and ^{182}W is presented. All the available data on these nuclei were collected including γ singles and coincidence spectra, β–γ coincidence spectra, conversion electron spectra, γ–γ angular correlations, and lifetime measurements. Analyses of the data were performed. The level schemes

of the nuclei were examined on the basis of the most probable quantum numbers of the excited states. Experimental values for the energies and intensities of transitions and the energies and lifetimes of levels were compared with the predictions of the Bohr–Mottelson theory of axial nuclei, the Davydov–Filipov theory of nonaxial nuclei, and the Davydov–Cabana theory of nonaxial nuclei in which β oscillations were considered. (tr-auth)

8992 LINEAR POLARIZATION AND $\gamma-\gamma$ DIRECTIONAL CORRELATION MEASUREMENTS IN ^{106}Pd. Weigt, P.; Herzog, P.; Richter, B.; Huebel, H.; Toschinski, H.; Fechner, J. (Univ., Bonn). Nucl. Phys., A122: 577-90(1968).

In a study of the level scheme of ^{106}Pd, the $\gamma-\gamma$ directional correlations of the 1045-512 keV and 616-512 keV cascades were measured. The linear polarization correlations were measured for the 1045-512 keV, 1050-512 keV, and 748-1045 keV cascades. The linear polarization at $\Theta = 90°$ was measured for the 1838-512 keV, 1200-1046 keV, 1394-1046 keV, and 221-1571 keV cascades. Spin, parity, and multipolarity assignments were derived. A redetermination of the half-life of the 2951-keV level did not confirm the previously reported value of $T_{1/2} = 200$ ns. Instead $T_{1/2} \leq 2$ ns. was found. (auth)

8993 THE DECAY OF ^{112}Ag. Lingeman, E. W. A.; Konijn, J.; Mathot, L. G. R. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A122: 557-66(1968).

The energies and relative intensities of the γ radiation following the decay of ^{112}Ag were measured using a Ge(Li) detector. A total of 103 γ rays was observed. Upper limits for relative intensities of possible γ rays are given. Spin and parity assignments for levels in ^{112}Cd were made. (auth)

8994 THE EVAPORATION OF α PARTICLES FROM HEAVY NUCLEI. Chenevert, G. (Univ. of Washington, Seattle); Halpern, I.; Harvey, B. G.; Hendrie, D. L. Nucl. Phys., A122: 481-511(1968).

Angular and energy distributions of emitted α particles were measured in α-particle bombardments of Ta, Au, and natural Pb at bombarding energies from 50 to 90 MeV. On the basis of the angular distributions and spectral shapes, it is possible to identify an evaporation component in the observed spectra. At backward angles, this component is generally an order of magnitude more intense than the other (direct-reaction) portion of the spectrum for outgoing α-particle energies between 15 and 25 MeV. For each bombarding energy and target, it was possible to determine values for the width of the evaporation spectrum and for the α-particle energy and the differential cross section at the peak of the spectrum. The observed values of these quantities were compared with those implied by the conventional statistical theory for particle evaporation from nuclei. It was found that the overall quantitative agreement between theory and experiment over the entire range of observation was remarkably good. For best agreement, the value of the level density parameter a appears to lie between $1/7$A and $1/10$A. Some possible modifications to the usual formulation of evaporation theory are briefly discussed in connection with the small discrepancies which appear between the observations and the theory. Finally some predictions of cross sections are given for the evaporation from heavy nuclei of protons, deuterons, tritons, and photons. (auth)

8995 PARTIAL RADIATIVE CAPTURE OF RESONANCE NEUTRONS IN SOME ISOTOPES OF TIN. Samour, C.; Julien, J.; Kuchly, J. M.; Alves, R. N.; Morgenstern, J. (CEN, Saclay, France). Nucl. Phys., A122: 512-28(1968). (In French).

Gamma-ray spectra of radiative neutron capture were studied in several tin isotopes with the Saclay linear accelerator using the time-of-flight method and a Ge(Li) detector. The intensity of 13 E1 transitions and 12 M1 transitions was evaluated. This study has shown that strong M1 transitions are on the average only five times less intense than E1 transitions. Some indications of the level schemes of four odd-mass nuclei and two even-mass nuclei were also obtained. (auth)

8996 HIGH-RESOLUTION MEASUREMENT OF THE FISSION CROSS SECTION OF ^{239}Pu BY RESONANCE NEUTRONS. Blons, Jacques; Eggermann, Charles; Michaudon, Andre (CEN, Saclay, France). Compt. Rend., Ser. A and B, 267: 901-4(Oct. 21, 1968). (In French).

The fission cross section of ^{239}Pu was measured between 16 eV and 35 keV by the neutron time-of-flight method, using the Saclay linear accelerator as a pulsed neutron source. The measurement was made with ^{239}Pu deposits carried to a temperature of 77°K and with a nominal resolution of 1 nsec/m. Some resonance groups appear with more intensity at certain energies when the mean spacing is about 350 eV. The effect is discussed and can be due to an intermediate structure in the cross section corresponding to the 1^+ channels. (tr-auth)

8997 $[(^{208}\text{Pb})_{3^-} \otimes (p_{1/2})^{-1}]$ DOUBLET IN ^{207}Pb. Grosse, E.; von Brentano, P.; Solf, J.; Moore, C. F. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 219: 75-8(1969).

Excitation curves measured to the $1/2^+$ and $5/2^+$ doublet in ^{207}Pb resonate selectively on the 5^- and 4^- analog resonances, respectively. This behavior is explained from the structure of the known wave functions involved. (auth)

8998 LOW-LYING LEVELS IN ^{143}Pm. Blasi, P. (Univ., Florence); Sona, P.; Taccetti, N.; Bocciolini, M. Nuovo Cim., 58B: 453-9(Dec. 11, 1968).

Gamma transitions between low-lying levels of ^{143}Pm populated in the decay of ^{143}Sm were investigated by means of lithium-drifted germanium detectors. Gamma-rays of 273, 1056, 1173, 1243, 1403, 1516, 1545 keV were detected; log ft values, levels, and spins of ^{143}Pm were deduced from intensity ratios and coincidence measurements. Evidence for the existence of a 273-keV level which is the $7/2^+$ predicted by the pairing plus quadrupole force theory of Kisslinger and Sorensen comes out particularly strong from the analysis of ^{143}Nd(p,nγ)^{143}Pm reaction data. (auth)

8999 1.7-MIN ISOMER IN ^{185}W. Daly, P. J.; Kleinheinz, P.; Casten, R. F. (Univ. of Copenhagen). Nucl. Phys., A123: 186-92(1969).

The decay of 1.7 min ^{185m}W was studied using a Ge(Li) detector. The isomeric level was identified as the $11/2^-$ $11/2^+[615]$ state located at 197.8 keV. The decay populates members of the $3/2^-[512]$ band at 0, 66.1, and 173.8 keV and of the $1/2^-[510]$ band at 23.6, 93.8, and 188.1 keV. The assignments are supported by preliminary results of ^{186}W(d,t) reaction studies. The rotational energies in the strongly perturbed $3/2^-[512]$ and $1/2^-[510]$ bands are well accounted for by a Coriolis calculation. (auth)

9000 GAMMA–GAMMA ANGULAR CORRELATIONS FOLLOWING COULOMB EXCITATION. Robinson, R. L.; McGowan, F. K.; Stelson, P. H.; Milner, W. T.; Sayer, R. O. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A123: 193-204(1969).

The triple correlation between two cascade gamma rays and a beam effecting Coulomb excitation was measured for transitions in ^{107,109}Ag, ^{110}Pd, ^{117}Sn, and ^{190,192}Os. These correlations were taken with the special geometry where one gamma-ray detector was placed at 0° relative to the incident beam. The results of this investigation coupled with previous information deduced from the angular distributions of the gamma rays following Coulomb excitation were used to establish E2/M1 admixtures and in the case of ^{117}Sn, spins of $5/2$ for the states at 1020 and 1448 keV. (auth)

9001 EXCITED NUCLEAR LEVELS IN DOUBLY EVEN Xe ISOTOPES POPULATED IN (α,2n) REACTIONS. Bergstroem, I. (Research Inst. for Physics, Stockholm); Herrlander, C. J.; Kerek, A.; Luukko, A. Nucl. Phys., A123: 99-113(1969).

Using the in-beam technique, gamma radiation from excited levels in the even Xe isotopes A = 124, 126, 128, 130, and 132 was studied. The nuclei are produced in (α,2n) reactions on enriched Te targets at a bombarding energy of about 28 MeV. From intensity and angular distribution measurements, members of the collective bands having spin and parity of up to 8^+ or 10^+ were assigned. On the basis of their angular distributions, a few dipole transitions were classified. These are tentatively interpreted as depopulation odd-parity two-quasi-particle neutron states. Indications of a new isomeric state in ^{130}Xe were found. Because of the gamma intensities observed, the transition order is changed in the decay of the earlier known 8.4 ms isomeric state in ^{132}Xe. Preliminary results from similar experiments on Te isotopes using Sn (α,2n)Te reactions are also reported. (auth)

9002 ELECTRIC QUADRUPOLE TRANSITION PROBABILITIES IN EVEN NUCLEI. De Aisenberg, E. Y.; Perez, M. L.; Suarez, J. F. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Phys., A123: 81-98(1969).

The collective E2 transition rates between allowed positive-parity states of even nuclei are computed using the rotational component of the wave function as well as its β- and γ-part. In 65% (90) of the 163 experimental intensity ratios compared with predicted values, agreement is found within a factor 2 (10). Axial asymmetry plays an important role to predict transition probabilities in the lanthanide region. (auth)

9003 FISSION COMPONENTS IN ^{242}Pu RESONANCES. James, G. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A123: 24-6(1969).

The fission cross section of ^{242}Pu shows two resonances near 800 eV with measurable fission width and a region of strong fission yield near 30 keV. These results are interpreted in terms of a second minimum in the fission potential barrier. (auth)

9004 DECAY OF ^{155}Sm. Ungrin, J.; Sujkowski, Z.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., A123: 1-23(1969).

The beta decay of ^{155}Sm was studied using Ge(Li), Si(Li), and NaI detectors singly and in two-parameter experiments. The half-life was measured to be 22.4 ± 0.3 min. The energies and intensities of 49 gamma rays were determined. These data and the results of the coincidence experiments led to the identification of the levels at 0.0 ($5/2^+$[413]), 78.5 ($7/2$, $5/2^+$[413]), 104.26 ($5/2^-$[532]), 169.0 ($7/2^-$[532]), 245.68 ($3/2^+$[411]), 307.4 ($5/2$, $3/2^+$[411]), 391.4 ($7/2$, $3/2^+$[411]), 768.23($5/2^+$), 817.55($5/2^+$), 876.9, 911.2, 922.8, 1096.9, 1101.6, 1106.7, 1263.0, and 1301.4 keV in ^{155}Eu. The numbers in parentheses give the spins and parities and the Nilsson description of the levels whenever possible. The branching ratios of the gamma rays from the 768.2- and 817.6-keV states and the absence of these levels in the deuteron spectra of the ^{155}Sm(^{3}He,d) ^{155}Eu reaction lead to a rejection of the previously proposed identification of the state at 768.2 keV with the Nilsson $1/2^+$[411] orbital. Evidence is adduced to show that the 768.2-, 817.6-, and 911.2-keV states are the $3/2^+$, $5/2^+$, and $7/2^+$ members of a rotational band based on either a $3/2^+$[422] hole state or on the β-vibrational state associated with the $3/2^+$[411] orbital. (auth)

9005 COMPENDIUM OF THERMAL-NEUTRON-CAPTURE γ-RAY MEASUREMENTS. PART II. Z = 47 TO Z = 67 (Ag TO Ho). Groshev, L. V. (Kurchatov Inst. of Atomic Energy, Moscow); Demidov, A. M.; Pelekhov, V. I.; Sokolovskii, L. L.; Bartholomew, G. A.; Doveika, A.; Eastwood, K. M.; Monaro, S. Nucl. Data, Sect. A, 5: 1-242(Nov. 1968).

A compilation is presented of thermal-neutron-capture γ-ray energy and intensity values with decay schemes, examples of original data, and fully corrected spectral distributions. An auxiliary table of data on stable isotopes with abundances, thermal-neutron radiative-capture cross sections, spins, parities, and other information of value to neutron-capture γ-ray spectroscopy is included. (auth)

Nuclear Theory

Refer also to abstracts 7906, 8810, 8819, 8909, 8921, 8936, 8946, 8950, 8956, 8970, 8990, 8991, and 9002.

9006 (TID-24667) MEDIUM ENERGY NUCLEAR PHYSICS WITH ELECTRON LINEAR ACCELERATORS. MIT 1967 Summer Study. Bertozzi, W.; Kowalski, S, (eds.) (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Contract AT-(30-1)-2098. 672p. (MIT-2098-470). Dep. CFSTI.

Separate abstracts were prepared for the 69 papers included. (D.C.W.)

For abstracts of individual papers see: 7777, 8713–8719, 8738, 8739, 8768, 8769, 8871–8885, 8923–8926, 8936, 8937, 8956, 9007–9041.

9007 (TID-24667, pp 93-112) TRENDS IN ELECTRON SCATTERING. Isabelle, D. B. ([Paris Univ., Orsay (France)]).

A survey is presented of the lines along which research on nuclear structure by electron scattering has proceeded. Formalisms for calculating the electron-nucleus interaction are outlined, together with corrections to raw scattering data. The information that can be obtained by elastic, inelastic, and quasi-elastic scattering experiments is discussed in terms of available results. (D.C.W.)

9008 (TID-24667, pp 146-9) INTRODUCTION TO INELASTIC SCATTERING. Ravenhall, D. G. (Illinois Univ., Urbana).

An approach to the analysis of electron inelastic scattering data is outlined in which the Born approximation cross section is calculated and the shift of the diffraction structure to smaller angles, as well as the filling in of the diffraction zeroes, is estimated by comparison with the elastic cross section under similar conditions. (D.C.W.)

9009 (TID-24667, pp 150-4) INELASTIC ELECTRON SCATTERING FOR NUCLEAR STRUCTURE STUDIES. Kisslinger, L. S. (Case-Western Reserve Univ., Cleveland, Ohio); Wu, Chi- Shiang (Case-Western Reserve Univ., Cleveland, Ohio. Victoria Univ. (British Columbia)).

The sensitivity of inelastic scattering to the structure of both collective and particle states was investigated. Calculations were performed using the first and second Born approximations and were restricted to the lowest 2^+ states in vibrational nuclei. (D.C.W.)

9010 (TID-24667, pp 155-66) SUM RULES FOR INELASTIC ELECTRON SCATTERING. Czyz, W. (Institute of Nuclear Research, Krakow (Poland)).

The formulation and validity of various sum rules for electron inelastic scattering are discussed. Sum rules based on the closure approximation and on time-dependent correlation functions are considered in detail. (D.C.W.)

9011 (TID-24667, pp 167-80) DISPERSION CORRECTIONS TO ELASTIC ELECTRON SCATTERING. Rawitscher, George H. (Connecticut Univ., Storrs. Dept. of Physics).

An approach to estimating dispersion corrections to electron elastic scattering is outlined in which the corrections are related to the experimental inelastic scattering cross section. Two experiments for observing the dispersion effects are suggested. (D.C.W.)

9012 (TID-24667, pp 181-5) PARTIAL WAVE CALCULATIONS OF INELASTIC ELECTRON SCATTERING. Verdier, Robin (Massachusetts Inst. of Tech., Cambridge).

A partial-wave analysis of electron inelastic scattering is outlined, and results are presented for the scattering of 183-MeV electrons by ^{208}Pb and ^{60}Ni. (D.C.W.)

9013 (TID-24667, pp 186-95) COULOMB CORRECTIONS. Drechsel, Dieter (National Bureau of Standards, Washington, D. C.).

Corrections for the distortion of electron trajectories by the strong static Coulomb field are discussed. The cross section for the electro-excitation of a discrete level is given in the distorted-wave Born approximation, and the numerical details of such a calculation are discussed. The model dependence of the correction factors for Coulomb effects is also considered. (D.C.W.)

9014 (TID-24667, pp 212-15) STUDY OF NUCLEAR MAGNETIZATION DISTRIBUTIONS BY MEANS OF 180° ELECTRON SCATTERING, COUNTING RATE ESTIMATES FOR THE CASE OF ^{209}Bi. Barber, W. C. (Stanford Univ., Calif.).

An extension of the determination of nuclear magnetization distributions by 180° electron scattering is outlined. Numerical results for the counting rate in electron scattering experiments on ^{209}Bi at 180° are presented. (D.C.W.)

9015 (TID-24667, pp 219-30) RADIATIVE CORRECTIONS. Lomon, Earle (Massachusetts Inst. of Tech., Cambridge).

A review of the present understanding of radiative corrections is presented, and the separation of the infrared and ultraviolet contributions is discussed. The consequences for the correction of experiments and for some formal features of quantum electrodynamics are outlined. (D.C.W.)

9016 (TID-24667, pp 231-48) RADIATIVE CORRECTIONS. Maximon, L. (National Bureau of Standards, Washington, D. C.).

The treatment of the radiative background in electron scattering experiments is discussed with emphasis on the radiation in the field of the same nucleus that is producing the nuclear scattering. Corrections to elastic scattering from charge distributions and magnetic moments, corrections to inelastic scattering, exponentiation, higher Born corrections, and kinematic recoil corrections are considered. (D.C.W.)

9017 (TID-24667, pp 249-50) RADIATIVE CORRECTION FOR INELASTIC ELECTRON SCATTERING. Maximon, L. C. (National Bureau of Standards, Washington, D. C.).

The result of a calculation of the radiative correction to the first Born approximation cross section for inelastic scattering of high-energy electrons is presented. (D.C.W.)

9018 (TID-24667, pp 251-64) LINE SHAPES AND THE RADIATIVE TAIL NEAR THE ELASTIC PEAK. Bergstrom, J. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

A relation for the line shape is derived by folding together Landau straggling, small-angle bremsstrahlung, and radiation emitted during a large-angle scattering in a simple calculation based on unsophisticated approximations for the distribution functions. Approximate expressions are given for the line shape and the radiative tail. An expression for the area of the peak out to some arbitrary cutoff energy is also included. The modification of the single-photon cross sections in order to describe the total tail in the region of approximately 0.5 to 10 MeV from the elastic peak is discussed. (D.C.W.)

9019 (TID-24667, pp 265-7) INFLUENCE OF THE RADIATIVE BACKGROUND ON MUON AND ELECTRON SCATTERING FROM NUCLEI. Maximon, L. C. (National Bureau of Standards, Washington, D. C.); Tzara, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The influence of radiative tails and radiative corrections to inelastic scattering on nuclei at low excitation is compared for muons and electrons. It is found that only for low momentum transfers $Q < 50$ MeV/c is the radiative background substantially less for muons than for electrons. (auth)

9020 (TID-24667, pp 271-86) TWO NUCLEON SYSTEM AND THE ELECTROMAGNETIC INTERACTION. Lomon, E. (Massachusetts Inst. of Tech., Cambridge)

The various electromagnetic interactions and their connection with proposed two-body forces are discussed. (D.C.W.)

9021 (TID-24667, pp 319-24) DEFINITIONS CONCERNING CORRELATIONS. Danos, M. (National Bureau of Standards, Washington, D. C.).

The definition and derivation of correlation functions for nucleons in nuclei are discussed. (D.C.W.)

9022 (TID-24667, pp 325-9) GROUND STATE CORRELATIONS. de Forest T. (Massachusetts Inst. of Tech., Cambridge).

The prospects for measuring the short-range correlations in nuclei are discussed. The type of process in which two nucleons are emitted from the nucleus when the excitation can be described by a one-body operator is considered in detail. (D.C.W.)

9023 (TID-24667, pp 330-45) INFLUENCE OF CORRELATIONS IN NUCLEI. Danos, M. (National Bureau of Standards, Washington, D. C.).

The testing of correlations by fast n-body reactions is discussed using the (γ,α) and (γ,p) reactions as examples. The quenching of the dipole resonance by short-range correlations is considered. (D.C.W.)

9024 (TID-24667, pp 346-55) ELECTROMAGNETIC TRANSITION RATES AND CORRELATIONS. Shakin, C. (Massachusetts Inst. of Tech., Cambridge).

An investigation of the effects of short- and long-range correlations on the calculation of form factors or electromagnetic transition rates is summarized. Transition strengths for dipole states in ^{16}O were calculated with and without Pauli corrections. Form factors for electron inelastic scattering by ^{6}Li and ^{16}O were calculated with and without Pauli and occupation number corrections. (D.C.W.)

9025 (TID-24667, pp 359-68) SCATTERING OF VERY HIGH ENERGY PARTICLES FROM NUCLEI AND NUCLEON-NUCLEON CORRELATIONS. Czyz, W. (Institute of Nuclear Physics, Krakow (Poland)).

The prospects for obtaining information on nuclear structure and on the $\pi-N$ or $N-N$ scattering amplitudes from high-energy scattering experiments are discussed on the basis of analyses of a CERN experiment on the scattering of 20-GeV protons from light, medium, and heavy nuclei; a Brookhaven experiment on the scattering of 1.7-GeV/c protons on protons, deuterons, ^{4}He, ^{12}C, and ^{16}O; and a Stanford experiment on electron elastic scattering by ^{4}He at high momentum transfers. The formulation and application of the Glauber model is emphasized. (D.C.W.)

9026 (TID-24667, pp 369-81) ANALYSIS OF HIGH ENERGY PROTON EXPERIMENTS. Wilkin, Colin (University Coll., London (England). Dept. of Physics).

The analysis of high-energy proton scattering experiments in the framework of the Glauber approximation is discussed, with consideration of the appropriate formulation of the nuclear model. It is shown that the Glauber formalism works for small angles, the exceptions being attributable to some feature such as spin dependence or an unsatisfactory nuclear model. (D.C.W.)

9027 (TID-24667, pp 382-96) HIGH ENERGY PROTON SCATTERING EXPERIMENTS. Palevsky, H. (Brookhaven National Lab., Upton, N. Y.).

Some research on nucleon correlations in nuclei is discussed. The requirements on an experimental facility for such research are outlined, and some equipment that has been developed in this program is described. Elastic and inelastic scattering experiments, and experiments on clustering in nuclei, are discussed including the analysis of the data. (D.C.W.)

9028 (TID-24667, pp 417-23) HIGH ENERGY PROTON-NUCLEUS EXPERIMENTS. Gillespie, John (Stanford Linear Accelerator Center, Calif. Ecole Polytechnique, Paris (France). Centre de Physique).

Some high-energy proton scattering experiments are discussed with emphasis on the use of such experiments in studying nuclear structure. The analysis of the data is considered in detail, particularly for experiments involving particle production below the threshold. (D.C.W.)

9029 (TID-24667, pp 427-42) (e e'p), (e, e'n), (ee'np) REACTION. Cortellessa, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica).

The performance of (e,e'p), (e,e'n), and (e,e'np) experiments is discussed on the basis of some (e,e'p) data already obtained. The momentum balance in such processes is considered in detail. The analysis of the data is discussed; and the possibility of performing (e,e'n), (e,e'pn), (e,e'γ), and (e,e'α) experiments is examined. (D.C.W.)

9030 (TID-24667, pp 443-54) (p,2p) EXPERIMENTS. Gottschalk, B. (Northeastern Univ., Boston, Mass.).

The principles behind the study of knockout reactions are discussed with emphasis on the determination of proton momentum distributions in nuclei by (p,2p) experiments. It is shown that there is a good degree in sets of (p,2p) data from various laboratories if the data are interpreted by the knockout model and that even the distortions seem to show a rather systematic behavior. (D.C.W.)

9031 (TID-24667, pp 455-63) (p,pα) EXPERIMENTS. Gottschalk, B. (Northeastern Univ., Boston, Mass.).

The investigation of clustering in nuclei by (p,pα) coincidence experiments is discussed on the basis of some data obtained for the reaction $^{12}C(p,p\alpha)^{8}Be$ at 160 MeV. Specifically, kinematic considerations that permit observation of direct knockout events are outlined, together with the analysis of the data in terms of the direct knockout model. (D.C.W.)

9032 (TID-24667, pp 474-7) (e,e'x) AND RELATED REACTIONS. FEW SUGGESTIONS FOR EXPERIMENTALISTS AND THEORETICIANS. Cortellessa, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica); Mougey, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The interpretation of data from direct reactions such as (e,e'p), (e,e'p), etc., and the companion reaction (p,2p) is discussed, together with the selection of kinematic conditions for such experiments. (D.C.W.)

9033 (TID-24667, pp 478-9) COUNTING RATE FOR SOME TYPICAL COINCIDENCE EXPERIMENTS (e,e'p), (e,e'n), (e,e'α). Cortellessa, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica).

The calculation of counting rates for (e,e'n), (e,e'p), and (e,e'α) coincidence experiments is briefly discussed; and the relative weight of proton detection solid angle and proton detection energy interval is examined on the basis of numerical calculations for two different experimental arrangements. (D.C.W.)

9034 (TID-24667, pp 480-1) WITH REGARD TO NUCLEAR CORRELATIONS: PRESENT STATUS AND PROJECTED FUTURE OF (γ,np) EXPERIMENTS: SOME OPEN THEORETICAL QUESTIONS OF INTEREST TO EXPERIMENTALISTS; BIBLIOGRAPHY. Matthews, J. L. (Massachusetts Inst. of Tech., Cambridge).

The type of information on nuclear correlations that has been obtained by (γ,np) experiments is outlined, together with some proposed experiments that may provide information on the nuclear pair correlation function. The design of experiments to permit observation of correlation effects is emphasized. 17 references. (D.C.W.)

9035 (TID-24667, pp 485-94) PHOTONS IN NUCLEAR REACTIONS. Schuhl, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Elements of photonuclear reaction theory are summarized, and the experimentally observed features of such reactions are outlined. Photon sources are briefly discussed, as is the design of photonuclear reaction experiments. (D.C.W.)

9036 (TID-24667, pp 495-6) PHOTOPRODUCTION AND RADIATIVE CAPTURE OF PIONS. Ericson, T. (European Organization for Nuclear Research, Geneva (Switzerland)).

The difficulty in obtaining monoenergetic γ beams for $(\gamma,\pi^{\pm})$ experiments is noted to be the basis for the interest in the inverse $(\pi^{\pm},\gamma)$ processes, and the theoretical interest in the (γ,π) reaction is demonstrated by a comparison between the radiative π^{-} and μ^{-} captures. The results of some experimental studies of (π,γ) reactions are summarized. (D.C.W.)

9037 (TID-24667, pp 497-502) PRODUCTION OF PIONS. Saunders, Les (Imperial Coll. of Science and Tech., London (England)).

An investigation of the information that can be obtained from the electroproduction or photoproduction of pions from nuclei is outlined. Numerical calculations were made using the dispersion formalism of Chew, Low, Goldberger, and Namu for photoproduction and the formalism of Fubini, Nambu, and Wataghin for electroproduction. (D.C.W.)

9038 (TID-24667, pp 505-11) GAMMA RAY EXPERIMENTS WITH AN ELECTRON ACCELERATOR. Alston, W. J.; Booth, E. C.; Chasan, B. (Boston Univ., Mass.).

The types of information that can be obtained by electron scattering experiments on nuclei are outlined, and experimental considerations are discussed including counting rates and data analysis for γ singles and $e-\gamma$ coincidence measurements. (D.C.W.)

9039 (TID-24667, pp 515-19) SOME RESULTS ON THE SPECTRA OF REAL PHOTONS. Schuhl, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

A brief analysis of the photon spectra resulting from the bremsstrahlung process and from positron annihilation in flight is presented. The polarization of bremsstrahlung photons and the production of monochromatic bremsstrahlung beams are considered. (D.C.W.)

9040 (TID-24667, pp 611-25) GENERAL ASPECTS OF π-NUCLEAR PHYSICS. Ericson, T. (European Organization for Nuclear Research, Geneva (Switzerland)).

A general survey of π-nucleus interactions is presented with emphasis on the use of pions as a probe of nuclear structure. Mesic atoms are considered as well as pion reactions and scattering. The status of the theory is discussed on the basis of experimental observations. (D.C.W.)

9041 (TID-24667, pp 637-9) ACTIVATION EXPERIMENTS WITH PIONS. Isabelle, D. B. (Clermont-Ferrand Univ. (France); Williamson, C. F. (Massachusetts Inst. of Tech., Cambridge).

The interest in pion activation experiments is outlined, and types of reactions and background corrections are discussed. Calculations of counting rates for such experiments are included. (D.C.W.)

9042 NEW APPROACH TO CALCULATIONS OF NUCLEAR MOMENTS OF INERTIA. Wong, S. K. M.; Tienhaara, M. I.; Trainor, L. E. H. (Univ. of Toronto). Phys. Rev. Lett., 21: 1819-22(Dec. 30, 1968).

A new approach to moment-of-inertia calculations yields a formula superior to the usual cranking-model formula and casts doubt on the apparent success achieved with pairing-force theory in cranking-model calculations. (auth)

9043 OAKES THEORY OF WEAK INTERACTIONS AND PARITY-NONCONSERVING NUCLEAR FORCES. McKellar, Bruce H. J. (Univ. of Sydney). Phys. Rev. Lett., 21: 1822-4 (Dec. 30, 1968).

The parity-nonconserving nucleon-nucleon potential is calculated from the Oakes theory of weak interactions on the assumption that π and ρ exchange terms dominate. It is found that this theory predicts a circular polarization of $\pm(1.8 \pm 0.9) \times 10^{-4}$ for 482-keV γ ray from ^{181}Ta. The observed polarization is $-(0.06 \pm 0.01) \times 10^{-4}$. (auth)

9044 COMPOUND-NUCLEUS EFFECTS IN (p,n) CHARGE-EXCHANGE REACTIONS ON LIGHT NUCLEI. Richter, A.; Parish, L. J. (Florida State Univ., Tallahassee). Phys. Rev. Lett., 21: 1824-8(Dec. 30, 1968).

Evidence is presented for the importance of compound-nucleus effects in (p,n) charge-exchange reactions on light nuclei for proton energies near 12 MeV. A convenient method is proposed to estimate the magnitude of the compound cross section based on elastic proton-scattering cross sections. (auth)

9045 FINE STRUCTURE OF ANALOG RESONANCES. Zaretskii, D. F.; Urin, M. G. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 8: 731-7(Oct. 1968). (In Russian).

A description of resonance (p,p') and (p,n) reactions proceeding with production of the analog states is presented. On the basis of the assumption about the "internal" Coulomb mixing, some formulas are obtained for the cross sections of these reactions averaged over components of the fine structure. (auth)

9046 INVESTIGATION OF THE ACCURACY OF APPROXIMATE METHODS IN SUPERFLUID NUCLEAR MODEL. Boshan, P.; Pavlikovski, A.; Rybarska, V. (Univ. of Bratislava). Yadern. Fiz., 8: 721-6(Oct. 1968). (In Russian).

A model was considered involving the interaction of six particles with the potential $-G\Sigma_{ss'} a^+_{s+} a^+_{s-} a_{s'-} a_{s'+} - \varkappa/2 \Sigma_{ss'\pi'} f_{ss'} f_{\pi'} a^+_{s\sigma} a_{s'\sigma} a^+_{s\rho} a_{s'\rho}$ which are located on the five twofold degenerate equidistant levels. The influence of the multipole-multipole term was investigated by varying the $\varkappa$ and $f_{ss'}$ parameters. The energy eigenvalues are exactly found in the framework of this simple model. The results are compared with approximate values obtained under the u-v transformation and by the method of approximate second quantization. (auth)

9047 STABILITY OF SUPERHEAVY NUCLEI. Muzychka, Yu. A.; Pashkevich, V. V.; Strutinskii, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 716-20(Oct. 1968). (In Russian).

Shell corrections and deformation energies are calculated for a number of superheavy nuclei. (auth)

9048 EFFECT OF PARAMETERS OF THE OPTICAL MODEL ON THE CHANNEL ANALYSIS OF THE NEUTRON-INDUCED NUCLEAR FISSION. Ermagambetov, S. B.; Kolesov, V. E.; Nesterov, V. G.; Smirenkin, G. N.; Tishin, A. S. Yadern. Fiz., 8: 704-12 (Oct. 1968). (In Russian).

Sensibility of the channel analysis of the neutron-induced nuclear fission to parameters of the optical model, is discussed. It is shown that the neutron penetrability given in the atlas BNL-765, used often for channel analysis is in poor agreement with the cumulative experimental data on interactions of neutrons with nuclei. With this in view an attempt is undertaken to estimate results of preceding works critically. (auth)

9049 CALCULATION OF THICK TARGET ELECTRON BREMSSTRAHLUNG SPECTRA WITH COLLIMATION AT HIGH ENERGIES. Tait, N. R. S. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Nucl. Instrum. Methods, 67: 56-60(Jan. 1, 1969).

Calculations have been performed of the spectral distribution of bremsstrahlung photons produced by high energy electrons in targets of thickness up to several tenths of a radiation length. Consideration is given to the influence of a collimator on the energy distribution of the photons. It is shown that collimation can lead to considerable relative enhancement of the high energy content of thick target spectra, particularly for collimators subtending angles of the order of m/E_0 at the bremsstrahlung target. In the calculation of the un-collimated thick target spectrum shape, allowance is made for the emission of more than one photon by the same electron and for the loss of photons by pair production and Compton scattering. The thin target Bethe-Heitler cross section is used in the computation. Consideration of multiple Coulomb scattering of the incident electrons in the target and their subsequent emission of bremsstrahlung with an angular distribution derived from the Schiff cross section leads to an estimate of the effect of collimation on the thick target spectral distribution. The relative importance of the various processes is discussed and some examples are given of the results of the computations. (auth)

9050 APPLICATION OF THE MULTI-CONFIGURATION HARTREE-FOCK THEORY TO A SIMPLE MODEL. Abecasis, S. M. (Laboratorio de Radiaciones, Buenos Aires); Faessler, Amand; Plastino, A. Z. Phys., 218: 394-400(1969).

The Lipkin model is extended to yield a nontrivial Hartree-Fock (HF) solution for any coupling constant of the two-body force. In this model, the multi-configuration Hartree-Fock (MCHF) approach is compared with the exact solution and with the HF solution. The results show a strong superiority of the MCHF method over the HF approximation. (auth)

9051 RANDOM PHASE APPROXIMATION AND CONTINUUM STATES. Fliessbach, Torsten (Technische Hochschule, Munich). Z. Phys., 218: 385-93(1969).

For scattering of nucleons the possibilities of including ground-state correlations are investigated in a formalism similar to the usual shell model formalism. It is shown that the effect of the ground-state correlations may be considerable. (auth)

9052 CHARGE SYMMETRICAL PAIRING CORRELATIONS FOR EVEN-EVEN NUCLEI WITH N = Z. Hiehs, Eduard; Hertenberger, Gerhard. Z. Phys., 218: 378-84(1969).

A generalized Bogolyubov Transformation was introduced to include (L = 0, S = 1, T = 0) pairs of unlike particles in the ground state in addition to (L = 0, S = 0, T = 1) pairs for like particles. Assuming a charge symmetrical interaction for light nuclei with N = Z, it is shown that the number of independent parameters of transformation is reduced from four to three. As a consequence, the quantities characterizing the ground state, the density operator ρ and the pairing tensor κ, assume the simplest possible form. The analytically soluble case of a single degenerate l-shell is treated assuming an extreme pairing force. (auth)

9053 POSSIBILITY FOR ESTIMATING THE SLATER INTEGRALS. Rudak, E. A. (Inst. of Physics, Minsk). Yadern. Fiz., 8: 713-15(Oct. 1968). (In Russian).

The Slater integrals of central forces are calculated by means of the function of the reduced angular interaction. The present method applied to the odd-odd nuclei ^{92}Nb and ^{210}Bi gives results that are close to those calculated with the Gaussian potential and with the oscillator wave functions. (auth)

9054 ON PHENOMENOLOGICAL THEORY OF ANALOGUE RESONANCES. Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., A122: 645-56(1968).

It is shown that the resonance rescattering in the initial and final channels gives rise to the fine structure of analog resonances. By means of an approximation to the unitarity condition, formulas are derived which describe the energy behavior of the cross section and the connection between partial and total widths. The results obtained are valid in the region of non-overlapping levels of the compound nucleus. (auth)

9055 AN AVERAGE SET OF OPTICAL TRITON PARAMETERS OBTAINED FROM THE FIT OF (t,p) ANGULAR DISTRIBUTIONS. Barz, H. W.; Hehl, K.; Riedel, C. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A122: 625-32(1968).

The angular distributions of (t, p) reactions leading to 0^+ and 2^+ states in ^{50}Ca, $^{65}Cu(3/2^-$ L = 0 ground state and $5/2^-$ L = 2 state), ^{120}Sn, ^{156}Sm, ^{210}Pb, and ^{240}U were fitted to derive 12-MeV optical triton parameters. A mass-independent set of optical potential parameters is obtained which gives good agreement between theory and experiment for all nuclei considered. This set of parameters is suitable for reproducing the shape of angular distributions for L > 2. The influence of different triton parameters on relative cross sections is discussed. (auth)

9056 ON REACTIONS WITH TRANSFER OF TWO PARTICLES. Rotter, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A122: 567-76(1968).

A formula is given for the structure factor determining the excitation of any level of the final nucleus in reactions between complex nuclei. All intermediate states formed by the transferred nucleons which are compatible with the quantum numbers of the nuclei are taken into account. The reactions (^{6}Li, α) and (^{18}F, ^{16}O), on light nuclei are considered in detail. Predictions are given also for the (d, ^{6}Li) and (t, ^{7}Li) reactions on ^{16}O and ^{12}C with transfer of four particles. (auth)

9057 ANALYTICAL SOLUTION FOR S-STATE WITH THE WOODS-SAXON POTENTIALS. Ishidzu, Takehiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 796-807(Oct. 1968).

Bose et al. have shown for several years that the Schroedinger equation with the Woods–Saxon and derivative Woods–Saxon potentials can be solved in analytical form for S-state neutrons. An explicit expression for the wave function, however, has not yet been given except in a paper of Bencze. An approximate analytical expression for the energy equation of bound S-states is derived, and also corresponding expressions for the phase shift and the scattering length of S-wave scattering are obtained. The mass numbers at which the 3s and 4s giant resonances occur in the low-energy neutron scattering are compared with experiment and with the results of a few other numerical calculations. (auth)

9058 SEPARATION OF THE CENTER-OF-MASS IN INDEPENDENT PARTICLE SYSTEMS. Aviles, Joseph B. Jr. (Naval Research Lab., Washington, D. C.). Ann. Phys. (N.Y.), 50: 393-406(1968).

It is shown that if an independent-particle Hamiltonian can be separated into a center-of-mass and internal part, it must be a second degree polynomial in the momentum and position operators. In particular, the spin can enter only through an additive term which is independent of the orbital quantities. If the masses of the particles are the same then the single-particle Hamiltonians must be the same; this rules out the possibility of treating protons and neutrons differently in a separable, independent-particle Hamiltonian. Invariance requirements further restrict the form of the Hamiltonian. (auth)

9059 ON THE BHMM STRIPPING ANALYSIS. McCarthy, I. E. (Flinders Univ., Bedford Park, Australia). Ann. Phys. (N.Y.), 50: 407-10(1968).

The comments of Rodberg on the BHMM stripping analysis are analyzed in the light of a model for the process which includes core degrees of freedom explicitly. The model supports the conclusions of BHMM. (auth)

9060 GROUND-STATE CORRELATIONS BY COLLECTIVE NUCLEAR EXCITATIONS. Schmidt, Kurt (Univ., Giessen, Ger.). Z. Phys., 219: 44-54(1969). (In German).

Applying the Fermi model, ground-state correlations are calculated in the quasiparticle formalism. Their dependence on the interaction potential strength, distance of energy levels, and pairing is investigated. By means of the normalization constant of the ground state the quasi-boson approximation is criticized. (auth)

9061 COULOMB DISPLACEMENT ENERGIES OF ISOBARIC ANALOGUE STATES. II. Lindner, Albrecht (Univ., Hamburg). Z. Phys., 219: 1-4(1969). (In German).

The conclusions of part I [Z. Physik, 211: 195(1968)] are revised: the nuclear energy changes within an isomultiplet, so that the change in the charge radius can not be derived from the energy difference. The three-parameter formula for the charge density does not remove the discrepancy found in heavy nuclei with the two-parameter formula. (auth)

9062 TERNARY FISSION OF ATOMIC NUCLEI. Benisz, Jerzy. Zesz. Nauk. Wyzsz. Szk. Pedagog. Katowicach, Sekc. Fiz., No. 6, 175-85(1968). (In Polish).

The available data on ternary fission of heavy nuclei were analyzed. Ternary fission of nuclei with emission of alpha particles and particles with $Z \neq 2$ was discussed. 43 references. (auth)

9063 CLUSTER PROPERTIES OF LIGHT NUCLEI. Rotter, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 16: 195-259(1968). (In German).

Experimental data show that in the levels of light nuclei various cluster structures exist at the same time with a certain probability. A theory which describes the cluster structure of the nucleus must therefore be capable of expressing the probability for these various structures. The assumptions on the cluster properties, which yield the cluster model and shell model, were reported and compared with each other. The method developed on the basis of the shell model is one which makes it possible to give quantitative data on the various cluster structures of a nuclear level. This method is described, and the results obtained with it are discussed. A method for the calculation of genealogical multiparticle coefficients was given, from which the reduced cluster widths could be calculated. Those reactions which can yield direct information on the cluster structure of nuclei were discussed. As examples reactions of the (p,pα) type at high proton energy and reactions of the (^{6}Li,α) type at relatively low energies of the lithium ions were discussed. It was shown on the basis of examples how far the assumptions made in the calculation of the reduced cluster widths within the framework of the shell model are fulfilled and when corrections to the results must be introduced. 88 references. (tr-auth)

9064 INDIVIDUAL PARTICLE DESCRIPTION OF NUCLEAR GIANT RESONANT STATES. Tomusiak, E. L. (Univ. of Saskatchewan, Saskatoon, Canada). Amer. J. Phys., 36: 1096-1102 (Dec. 1968).

The isospin, spin, and spin–isospin modes of collective nuclear excitation are reviewed in a form suitable for presentation in a graduate-level nuclear physics course. The transition charge and current densities as given by a shell-model description of these collective states are compared to those of the hydrodynamical theory. These densities are demonstrated to be identical in form if the individual-particle model is based on an oscillator potential and if the usual custom of keeping only the first derivative in a Taylor expansion of the hydrodynamical charge operator is adopted. Only doubly closed-shell nuclei with N = Z are considered. (auth)

9065 THE BETHE–WEIZSAECKER MASS FORMULA AND LENNARD-JONES N–N POTENTIALS. Wesley, James Paul (Univ. of Missouri, Rolla); Green, Alex E. S. Amer. J. Phys., 36: 1093-9(Dec. 1968).

An elementary derivation of the Bethe–Weizsäcker semiempirical nuclear mass formula, which is in the spirit of current views of nuclear structure, is given. Lennard–Jones potentials are assumed to act between nucleons. Thus the major interaction between nn, pp, and np pairs is taken of the form $-g/r^3 + h/r^4$, where r is the separation distance between nucleons, and g and h are constants. An additional "symmetry" interaction of the form $-s/r^3$ is assumed for np pairs. Summing the potential energy over all nucleon pairs and using the Fermi statistical estimate of the kinetic energy, the Bethe–Weizsäcker semiempirical mass formula is obtained directly. The constants of the mass formula are discussed in relation to the N–N interaction and are found to be quite plausible. (auth)

9066 STUDIES IN THE NUCLEAR CLUSTER MODEL. I. MATRIX ELEMENTS IN THE SUPERMULTIPLET SCHEME. Kramer, P.; Seligman, T. H. (Univ., Tuebingen, Ger.). Nucl. Phys., A123: 161-72(1969).

The matrix elements of two-body interactions between the most general states of n nucleons characterized by the supermultiplet and L–S coupling scheme are considered. The matrix elements can be expressed in terms of reduced matrix elements with respect to the symmetric and rotation group. Reduced matrix elements with respect to the symmetric group result from the separation of the last pair or from the use of tensor operators. These two types of matrix elements are derived and analyzed. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 7664.

9067 (ACNP-68505-G(Suppl.)) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME VII. WASTE COLLECTION AND TREATMENT. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 1968; Revised Oct. 1968. Contract AT(11-1)-850. 77p. Dep. CFSTI.

Operating procedures and equipment used for waste solution transfer at the La Crosse Boiling Water Reactor are detailed. (H.D.R.)

9068 (AEC-tr-7018) ARDENNES NUCLEAR POWER PLANT. Annual Report, 1967. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Translation of report EUR-4054. 21p. Dep. CFSTI.

Work carried out and results obtained during 1967 regarding the design, construction, operation, and financial position of the SENA nuclear power plant are summarized. (H.D.R.)

9069 (AECL-3071) THE GENTILLY NUCLEAR POWER STATION. Status Progress Report. Boucher, G. R. (Atomic Energy of Canada Ltd., Montreal (Quebec)). Nov. 1968. 36p. (In French and English). (CONF-680601-44). Dep. CFSTI. CAN $1.00.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A brief history of the Gentilly project is given along with the main organization arrangements with emphasis on the techniques used to assure that quality schedules and cost objectives are met. Construction of the prototype CANDU-BLW nuclear station started in September 1966 with full power operation scheduled for 1971. Progress to date is such that the cost and schedule objectives will likely be met. Design, planning and scheduling, procurement, quality control and expediting, cost control, commissioning and operation are discussed. One construction highlight was the "slip form technique" in which the concrete wall of the reactor containment building was poured continuously with the forms moving upward at four to six inches per hour. The operation, completed in 17 days, would have required five to six months by conventional methods. (auth)

9070 (AI-AEC-Memo-12648) PNPF CONTROL ROD MODIFICATION TERMINATION REPORT. Sobo, D. J. (Atomics International, Canoga Park, Calif.). May 14, 1968. 121p. Dep. CFSTI.

The results of all activities related to the PNPF Control Rod Modification Program up to the time of program termination are summarized. Starting with a description of the original PNPF control rod design, a discussion of the causes of unreliable operation is made. The basis and rationale for the modification are presented, and the design details are shown. The manufacturing and quality assurance programs are discussed, as are the coil winding and welding. Particular emphasis is placed on the details associated with the qualification of critical welds. The test program is presented and results discussed. (auth)

9071 (APDA-CFE-24) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, JULY-AUGUST 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Contract AT(11-1)-865. 36p. Dep. CFSTI.

Operations at the Fermi Fast Breeder Reactor during July to August 1968 are described. Remote-handling equipment and handling procedures for the removal of the remaining Zr plenum sections are described. Cooling system status during July to August is discussed. Core loading configurations and subassembly inspections are described. Maintenance required is also described. (D.C.C.)

9072 (DOCKET-50244-8) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Amendment 12, Suppl. 6, Exhibit D-9. (Rochester Gas and Electric Corp., N. Y.). Dec. 4, 1968. 240p. Dep. CFSTI.

Additional and revised information on the Robert E. Ginna Power Reactor, Unit 1 is given. Seismic evaluation of the reactor vessel internals is presented. Containment system structure changes are described. Stress analysis of the containment structure is presented. Safety injection pump requirements are described. Emergency shutdown control systems and procedures are described. Cable tray loading and separation requirements are given. Tritium control system for the reactor is described. Liquid waste disposal procedures and systems are described. (D.C.C.)

9073 (DOCKET-50245-7) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1. PROPOSED TECHNICAL SPECIFICATIONS. [Final Safety Analysis Report], Amendment 10. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Nov. 27, 1968. 86p. Dep. CFSTI.

The complete Proposed Technical Specifications for the Millstone Point Power Reactor, Unit 1 are given. Technical Specifications cover: safety limits and limiting safety system settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls. (M.L.S.)

9074 (DOCKET-50247-5) INDIAN POINT NUCLEAR GENERATING, UNIT NO. 2. Preliminary Safety Analysis Report, [Amendment 5], Suppl. 5, Exhibit B-5. (Consolidated Edison Co. of New York, Inc., New York). July 28, 1966. 50p. Dep. CFSTI.

A detailed description and analysis of the Emergency Core Cooling Systems for Indian Point Power Reactor, Unit 2 are given. Also included is a description of the reactor pit crucible. (M.L.S.)

9075 (DOCKET-50271-1) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. Plant Design and Analysis Report, Vol. 1. (Vermont Yankee Nuclear Power Corp., Rutland). Dec. 2, 1966. 505p. Dep. CFSTI.

Information on Vermont Yankee Power Reactor is presented on the following broad topics: Information and Summary; Station Site and Environs; Reactor Core; Reactor Coolant System; Station Containment Systems; Station Engineered Safeguards; Station Radioactive Waste Control Systems; Station Electrical Power Systems; and Station Instrumentation and Control Systems. (M.L.S.)

9076 (DOCKET-50271-2) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. Plant Design and Analysis Report, Vol. 2. (Vermont Yankee Nuclear Power Corp., Rutland). Dec. 2, 1966. 524p. Dep. CFSTI.

Information on Vermont Yankee Power Reactor is given on the following broad topics: Reactor Auxiliary, Station Service, and Plant Cooling Systems; Station Steam and Power Conversion System; Station Structures; Station Operations; and Station Safety and Accident Analyses. Appendices include: comparative evaluation with AEC Design Criteria, containment fission product retention capability, control rod drive system description and analysis, jet pump development program, reactor core spray cooling system test program, reactor core thermal design, site assembly of the reactor primary vessel, and seismic design criteria. (M.L.S.)

9077 (DOCKET-50271-3) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. Plant Design and Analysis Report, Vol. 3. (Vermont Yankee Nuclear Power Corp., Rutland). Dec. 2, 1966. 225p. Dep. CFSTI.

Design drawings and illustrations for Vermont Yankee Power Reactor are given on the following systems or subjects: site, core and internals, control rod drive system, primary system, nuclear steam supply system, pressure vessel, primary and secondary containment systems, core spray cooling systems, coolant loss accident effects, nuclear instrumentation, auxiliary systems, service water systems, condensate and feed water systems, turbine and steam extraction systems, and structures. (M.L.S.)

9078 (DOCKET-50271-6) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. [Plant Design and Analysis Report], Amendment 3. (Vermont Yankee Nuclear Power Corp., Rutland). Apr. 12, 1967. 175p. Dep. CFSTI.

Plant stability is analyzed for the Vermont Yankee Power Reactor, instability parameters, operating parameters, and experimental data are given. Thermal and thermal-hydraulic design of the core is discussed; data are shown graphically. Times required for ECCS responses in the event of a loss-of-coolant accident are given; capacities of the ECCS are listed. Design criteria for the Vermont Yankee site and structures are given. A main line steam break accident is analyzed in detail. Analyses of radiological effects of accidents are discussed by comparing the TID-14844 model, G. E. model, and a third model. Detailed comparisons between Vermont Yankee, Browns Ferry, and Monticello are tabulated. Availability analyses of off-site power and the station battery system are given. (M.L.S.)

9079 (DOCKET-50271-7) [VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT]. [Plant Design and Analysis Report], Amendment 4. (Vermont Yankee Nuclear Power Corp., Rutland). Apr. 28, 1967. 17p. Dep. CFSTI.

Replies to ACRS comments are given on the following systems: effect of fuel clad failure on emergency cooling, core spray effectiveness, control systems for emergency power, instrumentation improvements, steam line isolation valve testing, fuel orientation, fuel malfunctions due to improper cooling, fuel damage limit, design of rod block monitor system, diesel generator testing, quality assurance and testing of the primary system, in-service inspection, startup program, and discussion of comments of Dr. Stephen Hanauer (of the ACRS). (M.L.S.)

9080 (DOCKET-50271-8) [VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT]. [Plant Design and Analysis Report], Amendment 5. (Vermont Yankee Nuclear Power Corp., Rutland). May 19, 1967. 27p. Dep. CFSTI.

Redundant on-site emergency power, dc battery system, and alternate system for decay heat removal for the Vermont Yankee Power Reactor are discussed. The definition for the "Project Flood" is given. The radwaste building design is described. Revised pages of the PSAR are included. (M.L.S.)

9081 (DOCKET-50271-9) [VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT]. [Plant Design and Analysis Report], Amendment 6. (Vermont Yankee Nuclear Power Corp., Rutland). May 24, 1967. 12p. Dep. CFSTI.

A stability analysis of the Vernon Dam, near the Vermont Yankee Power Reactor site, is given. A reactor building crack analysis under maximum postulated earthquake is included. (M.L.S.)

9082 (DOCKET-50271-12) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. Addendum to Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Oct. 11, 1967. 6p. Dep. CFSTI.

An additional safety review is given of the Vermont Yankee Power Reactor with respect to the addition of cooling towers. (M.L.S.)

9083 (DOCKET-50302-9) CRYSTAL RIVER [NUCLEAR GENERATING PLANT], UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 3. (Florida Power Corp., St. Petersburg). Mar. 4, 1968. 74p. (DOCKET-50303-9). Dep. CFSTI.

Revised information on Crystal River Power Reactor, Units 3 and 4 is given on: compliance with AEC General Design Criteria, the construction inspection program, off-site power sources, electrical equipment in the containment which must survive a design basis accident, and initiation of ECCS operation. (M.L.S.)

9084 (DOCKET-50312-2) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 1. (Sacramento Municipal Utility District, Calif.). Nov. 1967. 667p. Dep. CFSTI.

Information on Rancho Seco Power Reactor, Unit 1 is given under the following main headings: Introduction and Summary; Site and Environment; and Reactor. (M.L.S.)

9085 (DOCKET-50312-3) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 2. (Sacramento Municipal Utility District, Calif.). Nov. 1967. 625p. Dep. CFSTI.

Information on Rancho Seco Power Reactor, Unit 1 is given on the following broad topics: Reactor Coolant System; Containment System; Engineered Safeguards; Instrumentation and Control; Electrical Systems; and Auxiliary and Emergency Systems. (M.L.S.)

9086 (DOCKET-50312-4) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 3. (Sacramento Municipal Utility District, Calif.). Nov. 1967. 282p. Dep. CFSTI.

Information on Rancho Seco Power Reactor, Unit 1 is given under the following broad topics: Steam and Power Conversion Systems; Radioactive Waste and Radiation Protection; Conduct of Operations; Initial Tests and Operations; and Safety Analyses. (M.L.S.)

9087 (DOCKET-50312-5) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 4. (Sacramento Municipal Utility District, Calif.). Nov. 1967. 452p. Dep. CFSTI.

A detailed meteorologic evaluation of the site for Rancho Seco Power Reactor, Unit 1, is given. Site land usage, population, geology, and seismology are discussed; complete reports on site geophysics and soil and foundations are included. Design bases for structures, systems, and equipment are listed; use of the Cadweld process for splicing the reinforcing bar is described. Considerations of effects of missiles from failed turbine generators are given; containment structural analysis procedures are described. Quality control procedures for field welding are discussed; containment structure instrumentation is described. (M.L.S.)

9088 (DOCKET-50312-6) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 1. (Sacramento Municipal Utility District, Calif.). Feb. 2, 1968. 525p. Dep. CFSTI.

Research and development programs for the Rancho Seco Power Reactor, Unit 1 are detailed. The quality assurance program is described. Fuel temperatures and DNB ratios are discussed; data are shown graphically. The preliminary design for prevention of vapor lock in the hot leg is discussed. Results of detailed reactivity calculations are given. Effects of thermal shock on the primary system components induced by Emergency Core Cooling System (ECCS) operation are analyzed; data are tabulated. The report, "The Properties and Microstructure of Spray-Quenched Thick Section Steels" is included; typical NDTT data for primary system steels are tabulated. Operation and efficiency of engineered safeguards are considered. Area and process monitoring systems are described; schematics are shown. Emergency plans, to be used in the case of a major accident, are outlined. Effects of loss-of-coolant accidents are discussed. The possibility of emergency injection water by-passing the core is evaluated; environmental effects of accidents which release methyl iodide are analyzed; use of thiosulfate spray is discussed. (M.L.S.)

9089 (DOCKET-50319-6) BELL STATION. [Preliminary Safety Analysis Report], Amendment 2. (New York State Electric and Gas Corp., Binghamton). Dec. 11, 1968. 3p. Dep. CFSTI.

An itemized estimate cost list for the Bell Power Reactor is presented. The financing plan for the power station is described. (D.C.C.)

9090 (DOCKET-50324-5) [BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Amendment 2. (Carolina Power and Light Co., Raleigh, N. C.). Dec. 9, 1968. 3p. (DOCKET-50325-5). Dep. CFSTI.

An itemized estimate cost list for the Brunswick Power Reactor Units 1 and 2 is presented. The financing plan for the power station is described. (D.C.C.)

9091 (EUR-4069) 50-MW(e) DODEWAARD NUCLEAR POWER PLANT. Annual Report, 1967. (Gemeenschappelijke Kernenergiecentrale Nederland N. V., Dodewaard. Samenwerkende Electriciteits-Productiebedrijven, N. V., Arnhem (Netherlands)). July 5, 1968. 136p. (In Dutch). Dep.

A large part of the fabrication and assembly of components was accomplished during 1967. The preparation and assembly of the fuel elements by NV Philips reached an advanced stage. Fabrication of the UO_2 pellets by the Nukem firm was completed. The containment system was also completed in 1967. The containment system was made by Werkspoor of Utrecht. The fabrication of the reactor vessel (and internals) by Rotterdamsche Droogdok was completed. The vessel was designed and built in accordance with the new ASME-III code and the requirements of the Stoomwezen Service, which inspected the vessel after completion. The nondestructive testing of the weld seams of the reactor vessel penetrations is described. The connecting up of the power plant's 150 kV system was fully completed. After the assembly of the containment system vessels, the biological shield in the reactor building and the steel construction on the reactor building were completed. Finally, activities in the field of instrumentation together with the physics and the thermohydraulics are also described. (auth)

9092 (EUR-4078) GUNDREMMINGEN (KRB) NUCLEAR POWER PLANT. Annual Report, 1967. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). July 5, 1968. Contract 005-63-4 REPD. 62p. (In German). Dep.

Following completion of the power and acceptance tests the power plant was able to start up in March and on April 29, 1967 it was taken over by the Kernkraftwerk RWE-Bayernwerk GmbH (KRB). Permission to operate the plant was at first only granted up to July 31, 1967. The plant was closed down in the middle of July for carrying out alterations, which were necessary in order to obtain permission from the authorities for operation over an unlimited period. A flow-limiter was installed in the primary steam line and the closing time of the two penetration valves was reduced to 5 seconds. During the shutdown, improvements to the stator-winding of the generator were carried out by AEG. The reactor core was also examined for leaking fuel elements. Three elements were removed and replaced by new ones. In September power-operation was continued. All primary steam and water circulation systems have been overhauled to make them as leak-

proof as possible. Thereafter, it was no longer necessary, as it often had been in the first ten months of power operation, to wear filter masks in the turbine house and reactor building because of high aerosol activity. At the beginning of December, modifications were carried out on the minimum-flow pipes of the feed-pumps. Frequent load restrictions imposed by the load despatcher during the summer meant that it was not until September that the plant could be operated at full load. The plant adapted to the load changes without difficulty. (auth)

9093 (GA-9047) RECENT OPERATING EXPERIENCE AT THE PEACH BOTTOM ATOMIC POWER STATION. Kantor, M. E. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 24, 1968. Contract AT(04-3)-314. 28p. (CONF-681101-6). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A brief description of the Peach Bottom Power Reactor, Unit 1, is given. A chronological account of 1967 and 1968 operations is detailed; plant availability is evaluated by month. Plant efficiency, controls, and transient behavior are discussed; temperature and xenon reactivity worths are shown graphically. Results of fuel element examination are discussed. 11 references. (M.L.S.)

9094 (GAMD-7691) FEED/BREED FUEL CYCLE IN THE 330 MWe PSC REACTOR. Traylor, R. C. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 10, 1967. Contract AT(04-3)-633. 37p. Dep. CFSTI.

Various schemes of the alternate ring feed/breed concept for the 330 MW(e) reactor core were subjected to analysis with one-dimensional depletion studies, two-dimensional diffusion theory calculations, fuel cycle cost computations, and some rudimentary heat transfer considerations. Results of these analyses were compared with the standard Public Service Company of Colorado fuel cycle—both non-recycle and recycle. The lowest fuel cycle costs for feed/breed are obtained only at the expense of high patch power density. This peaking appears to result in peak fuel temperatures that are greater than present PSC temperatures by nearly 300°F, and concurrently, an additional $5\frac{1}{2}$ psi pressure drop through the orifices and core. Attempts to reduce power peaking caused higher fuel cycle costs and made the feed/breed concept non-competitive. In any case, the standard once-through recycle fuel cycle produced the lowest fuel cycle costs. The relatively poor performance of this feed/breed concept appears to be due to (a) the large physical separation of the feed and breed regions and (b) the fact that the feed zones occupy too high a volume fraction of the core (37%). (auth)

9095 (GAMD-7900) PEACH BOTTOM CONTROL PERFORMANCE AND DYNAMIC BEHAVIOR. Dunning, T. G.; Kantor, M. E.; Long, H. A.; Schlicht, R. W. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 1, 1968. Contract AT(04-3)-314. 96p. Dep. CFSTI.

The transient performance of the Peach Bottom Power Reactor and the effects of the control and safety systems on operation are described. A comparison is made with the predicted performance as determined from the Peach Bottom Trainer-Simulator. The plant control philosophy and the controls and dynamics test programs are explained. The instrument hardware and the method of operation of the major control systems are given. The Trainer-Simulator is also described including physical layout, the mathematical model and assumptions used, and predictions of plant performance obtained by running the actual test program on the simulator. Plant instrumentation and special data acquisition and recording equipment used during the actual test program are discussed. Results of the test program comprising control system commissioning and performance, plant open loop responses, and safety system performance both at 30% and 100% reactor power are discussed. Conclusions are drawn about the performance of the systems and comparisons are made between simulator and actual test results. The results show that plant performance agrees well with predictions, and that the mathematical models used are representative of actual plant dynamics. The results also show that during load changes up to the design objective of 3%/min, steam temperature deviations are less than 10°F and steam pressure deviations are less than 15 psi, both quite satisfactory. (auth)

9096 (GAMD-8492) FELTMETAL FILTER STUDIES. Snow, B. D.; Perry, C. A.; Burnette, R. D. (Gulf General Atomic, Inc., San Diego, Calif.). July 18, 1968. Contract AT(04-3)-633. 18p. Dep. CFSTI.

An investigation was undertaken to study the effectiveness of sintered metal filters (Feltmetal) for the removal of graphite dust entrained in helium. The program was initiated to provide needed information on the performance of the high-temperature filter unit proposed for the Fort St. Vrain HTGR. Two series of tests were performed. The filtration efficiency of the Feltmetal material for 1 to 10 μ graphite dust was determined. The pressure drop across the filters was measured as a function of carbon dust loading, flow rate, total gas pressure, and temperature. The filters were found to be essentially 100% efficient for removal of 1 to 10 μ graphite dust. Pressure drop increased with flow rate and dust loading in an expected fashion. It was found that excessive accumulation of graphite dust on the filters could be easily removed by a simple backpurge technique. (auth)

9097 (NP-17709) NUCLEAR POWER: ITS POTENTIAL FOR ALUMINUM REDUCTION. Kaestle, F. L.; Marsh, W. D. (General Electric Co., Schenectady, N. Y.); Bigge, W. B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). [nd]. 20p.

The power requirements for the Al reduction plants of the near future are surveyed. A brief technical description and the basic economics of nuclear power plants are presented. Consideration of their use for both U. S. and off-shore Al reduction plants is discussed, and probable trends are indicated. (auth)

9098 (SwRI-1228-P-11-10) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT. DESIGN, CONSTRUCT, AND INSTALL TRACK ASSEMBLY FOR INSPECTION OF THE UPPER RECIRCULATION HEADER FROM THE REACTOR CAVITY ON LACBWR. Topical Report No. 6. Howell, R. C.; Lautzenheiser, C. E. (Southwest Research Inst., San Antonio, Tex.). Oct. 7, 1968. Contract AT(11-1)-1228. 18p. Dep. CFSTI.

Circular, ring-type tracks and a companion electric car are two of the mechanical equipment items for inspection of pipe welds on exterior surfaces. The tracks are two 180-degree arcs which bolt together to form a ring around a weld location. The outer surface of the tracks contains fixed gears which enable the electric car to be driven around the pipe. Grooves in the tracks guide, hold, and provide a running surface for the wheels of the electric car. To compensate for any changes or irregularities at the weld periphery, there is an annular space between the outside of the pipe and the inside of the track ring. In this space are leaf springs which press outward to hold the tracks while deflecting individually. Criteria for track design are listed, and design conformance along with the materials of fabrication are described. (auth)

9099 (SwRI-1228-P-11-11) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT. ULTRASONIC PRE-SERVICE INSPECTION OF SELECTED WELDS IN THE RECIRCULATION HEADER RINGS OF THE LaCROSSE BOILING WATER REACTOR PLANT. Topical Report No. 7. Whiting, A. R. (Southwest Research Inst., San Antonio, Tex.). Oct. 14, 1968. Contract AT(11-1)-1228. 28p. Dep. CFSTI.

A mechanized pre-service ultrasonic inspection was performed of selected portions of the LACBWR primary pressure boundary components. The techniques, standards, and instrumentation used on the reactor nozzle-to-safe end and safe end-to-piping welds of the outboard nozzle locations in both the inlet and outlet ring headers of the primary forced recirculation system are described. No reportable defects were noted in the pre-service inspection described. (auth)

9100 (TRG-Report-1631) FAST REACTOR DEVELOPMENT IN THE UNITED KINGDOM. Kronberger, H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 10p. Dep. CFSTI. UK 2s. 0d.

The progress in the U. K. of electricity production by nuclear power is described, and the concept of fast reactors in the logical development of this progress is analyzed. (auth)

9101 VIBRATION AND NOISES OF A HEAT EXCHANGER. Funakawa, Masaya (Kawasaki Dockyard Co., Ltd., Japan). FAPIG (Tokyo), No. 49, 39-47(June 1968). (In Japanese).

In the JAPC Tokai power station, damage occurred recently to the vaporization tubes of the steam generator. In order to pursue the causes for this accident, studies were carried on possible factors. From the experiment with model tube groups in the atmospheric-pressure air channel, it was confirmed that the vibrations of tubes could be measured and fatigue damage be produced. Under a specific flow velocity, a resonant peak appears in the vibration of tubes. The dimensionless vibration number, determined by the flow velocity at this point and the specific tube vibration number in the zigzag arrangement, is fairly large for the narrowed pitches, compared with the case of single tubes; it is about 1.3 against 0.2 for the latter. The resonance phe-

nomenon, observed for ordinary boilers due to the group of tubes, was also studied. (NSA of Japan)

9102 THE FUTURE OF NUCLEAR POWER GENERATION AND ITS ECONOMY. Nomura, Akio (Tokyo Electric Power Co., Inc.). Genshiryoku Kogyo, 14: No. 7, 12-21(July 1968). (In Japanese).

The future of nuclear power generation and its economy are described in the following sections: energy demands and supplies, and nuclear power generation; atomic power development in oversea countries and the economy; demands and supplies of electric power and development of the power sources in Japan; programs of nuclear power generation and the trend of its economy; factors in the estimate of its economy. (NSA of Japan)

9103 SPECIALITIES AND STATE OF DEVELOPMENT OF TURBINES FOR NUCLEAR POWER STATIONS. Araki, Ryoichiro; Okubo, Atsuo (Mitsubishi Heavy Industries, Ltd., Tokyo). OHM (Elec. Mag.), 55: No. 9, 49-54(Aug. 1968). (In Japanese).

The nuclear power generation in Japan is based on the light water reactor type. The steam turbine, used for the pressurized water type nuclear power plant, is introduced. The design of steam turbine makes no difference whether it is coupled with a BWR or a PWR. The output of No. 1 plant in Mihama power station of Kansai Denryoku Co. is 340MW, and that of No. 2 plant is 500MW. The design of a steam turbine for a nuclear power plant is explained, taking these turbines as examples. The turbine for a nuclear plant is driven with saturated steam of comparatively low pressure, such as 50 to 70 kg/cm^2, therefore its steam consumption is 1.6 to 1.8 times as much as the conventional steam turbine, and a low speed 4 pole machine is utilized. This type of turbine is tandem compound, consisting of one double-flow-high pressure element, 1 to 3 low pressure elements according to the output, and one generator, all connected in single shaft. The high pressure element is similar to the intermediate pressure turbine of the conventional type, and size and weight of low-pressure element are very large. Special considerations are given to moisture, and the moisture separating heater is installed on the cross-over pipe, connecting high pressure and low pressure turbines. (NSA of Japan)

9104 RADIATION CONTROL IN THE ATOMIC POWER STATION AT THE TIME OF ITS REGULAR INSPECTION. Nishikawa, Yoshiyuki; Tanaka, Mizue (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo, 14: No. 8, 51-4(Aug. 1968). (In Japanese).

The radiation control in a large power station is divided as follows: the stage of its construction, of its test operation, and of its actual operation (including the normal operation and the regular inspection). The radiation control, carried out at the time of its regular inspection when various repairs are done, is described. At the JAPC Tokai power station, the difference in radiation control between the normal operation and the regular inspection, work under intense radiations and the radiation control, and, problems in the radiation control are described. (NSA of Japan)

9105 138600 KW TURBINE FOR NUCLEAR POWER PLANT. Kumeno, Kozo (Hitachi, Ltd., Japan). Nippon Kikai Gakkaishi, 71: 1103-7(Aug. 1968). (In Japanese).

The 138.6 MW(e) nuclear power station, constructed in a suburb of Karachi, Pakistan, is expected to start its operation in 1970. Hitachi was awarded the order to build the turbine for the plant. Plant parameters are as follows: type of reactor, CGE natural U, heavy water moderated; type of turbine, impulse, tandem three casings, four flows exhaust, condensing; rated output 138.6 MW(e), at 3000 rpm; steam pressure and temperature at the entrance, 544 psig, 479.8°F; and blade length of the last stage, 23 in. This turbine is driven with wet steam through all stages, therefore the most important problems are the effective removal of moisture generated in way of expansion and the prevention of erosion due to water drops. A moisture separator of corrugated plate type is installed in the connecting pipes of the high and low pressure turbines, and stages with grooved blades are in the high and low pressure stages. The stellite protection plates and the surface hardening of low pressure blades are adopted against the erosion. The emergency governor is so set as to prevent over-speed due to large quantity of remaining steam in the connecting pipe. 2¼ Cr-1 Mo cast steel or 2 Cr cast steel is selected for the materials of diaphragms, casings, and valve bodies. (NSA of Japan)

9106 U. S. NUCLEAR INDUSTRY: HEALTHY AND STILL GROWING. Tremmel, E. B. (Atomic Energy Commission, Washington, D. C.). Power, 113: No. 1, 68-9(Jan. 1969).

An analysis of the variations in the nuclear power reactor orders during 1957 and 1968 is presented. Planned and forecasted fuel-conversion and fuel-reprocessing capacities to the year 1980 are presented. The outlook for the U. S. power reactor business is predicted. (D.C.C.)

9107 SWEDEN IS SHIFTING ITS NUCLEAR EMPHASIS. Strauss, Sheldon D. Power, 113: No. 1, 70-1(Jan. 1969).

The development of power reactors in Sweden is discussed. A comparison of water-cooled and heavy water-cooled power reactors is presented. Reasons for favoring water-cooled reactors are described. A description of the Oskarshamm Power Reactor is presented. (D.C.C.)

9108 GERMAN NUCLEAR INDUSTRY SHOWS IMMENSE PROGRESS. Jaroschek, Kurt (Darmstadt Univ., Ger.). Power, 113: No. 1, 72-3(Jan. 1969).

The development of nuclear power reactors and nuclear equipment in Germany is described. The present state of fast breeder reactor development is described. (D.C.C.)

9109 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (comp.). Nucl. Safety, 10: 108-15(Jan.-Feb. 1969).

Recent AEC regulatory or review actions are summarized for the following reactors: Connecticut Yankee (Docket 50-213), Crystal River 3 (Docket 50-302), Easton (Docket 50-300), Fort St. Vrain (Docket 50-267), Humboldt Bay (Docket 50-133), Kewaunee (Docket 50-305), Oyster Creek 1 (Docket 50-219), Pathfinder (Docket 50-130), Pilgrim (Docket 50-293), Russellville (Docket 50-313), Salem 1 and 2 (Dockets 50-272 and 50-311), N.S. Savannah (Docket 50-238), and Turkey Point 3 and 4 (Dockets 50-250 and 50-251). 26 references. (M.L.S.)

9110 PLANNING A MEDICAL UNIT FOR HANDLING CONTAMINATED PERSONS FOLLOWING A RADIATION ACCIDENT. Holland, R. W. (Oak Ridge National Lab., Tenn.). Nucl. Safety, 10: 72-84(Jan.-Feb. 1969).

Injuries sustained at the time of a radiation accident are relatively rare in the United States, but, as the use of nuclear energy expands, there may be more of them. In the years since the SL-1 incident in which three workers died, there has been much private discussion about the advisability of constructing decontamination facilities at sites where radiation accidents are possible, but little has been written for publication. Ideas and recommendations are presented on the design of such a decontamination facility. These ideas were formed by both industrial medical practice at ORNL and by discussion with personnel at various other sites. 28 references. (auth)

9111 LINGEN: A SURVEY OF THE GERMAN KWL PLANT. Deublein, O. (AEG-Telefunken, Frankfurt am Main). Nucl. Eng. Int., 13: 929-45(Nov. 1968).

A brief history of the project is given to introduce the series of 4 articles which describe the design features, fuel, instrumentation and control, and commissioning and start-up of the KWL plant. Separate abstracts are presented for the 4 articles. A folded chart gives a cut-away view of the reactor and lists the main parameters. A list of the contractors is appended. (UK)

For abstracts of individual papers see: 9112–9115.

9112 DESIGN FEATURES OF KWL. Traube, K.; Kornbilcher, S. (AEG-Telefunken, Frankfurt am Main). Nucl. Eng. Int., 13: 930-3(Nov. 1968).

The 240 MW(e) BWR plant with oil-fired superheater is described. Details are given of the principal innovations, which include an internal cyclone steam separator, continuously adjustable control rod drives, and in-core neutron sensitive thermocouples. A chronological list of the principal events during fabrication of the reactor is given, and the experience gained during start up is summarized. (UK)

9113 KWL FUEL. Fricke, W. (AEG-Telefunken, Frankfurt am Main). Nucl. Eng. Int., 13: 934-5(Nov. 1968).

The fuel elements consist of a 6 × 6 rod cluster contained in a detachable Zircaloy 4 channel. The fuel rods are thin-walled Zircaloy 2 tubes filled with UO_2 pellets. The design, fabrication, testing, and performance are discussed, and an outline is given of the fuel cycle. (UK)

9114 LINGEN: INSTRUMENTATION AND CONTROL. Schrufer, E.; Reinhardt, A. (AEG-Telefunken, Frankfurt am Main). Nucl. Eng. Int., 13: 935-8(Nov. 1968).

A review of the range of instruments available includes a description of the thermoelectric flux probe design. Output control is maintained through systems operating on the reactor, steam generator, superheater, and turbine plant, which are described. Reactor control is based on regulation of the recirculating flow, but since rod control was provided as a standby it is used additionally for increased efficiency and wider range control. (UK)

9115 COMMISSIONING AND START-UP OF KWL. Jaerscky, R.; Schulze, J. (AEG-Telefunken, Frankfurt am Main). Nucl. Eng. Int., 13: 939-44(Nov. 1968).

Details are given of the preoperational tests and of the tests at zero power and up to full load. The reactor physics program included safety and core design verification at zero power, temperature coefficient measurements and control checks during power build-up, and optimization of the rod patterns in the power range. (UK)

9116 NUCLEAR POWER IN EAST EUROPE. Polach, Jaroslav G. Resources for the Future Reprint Series, No. 74. Washington, D. C., Resources for the Future, Inc., 1968. 12p. Free, Additional Copies $0.25.

The growth of nuclear power in the European countries of Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Rumania is described. Predictions of nuclear power growth to 1975 for the same countries are also presented. (D.C.C.)

Power Reactor Development

9117 (GA-7453) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1966. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 7, 1967. Contract AT(04-3)-633. 176p. Dep. CFSTI.

BEARINGS—testing of Fort St. Vrain Power Reactor Unit 1 helium blower, performance
BLOWERS—bearings for Fort St. Vrain Power Reactor Unit 1 helium, performance testing of
BOILERS—testing of Fort St. Vrain Power Reactor Unit 1, analysis of vibration
CARBON MONOXIDE—sorption on Incoloy-800, Type-316 stainless steel, and chromium–molybdenum alloys, effects of time and temperature on
CERIUM ISOTOPES Ce-144—fission product release rate from irradiated BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle-type fuel, effects of annealing time and temperature on
CESIUM ISOTOPES Cs-137—fission product release rate from irradiated BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle-type fuel, effects of annealing time and temperature on
CHROMIUM ALLOYS AND SYSTEMS—Cr–Mo, sorption of carbon monoxide and helium gases by, effects of time and temperature on
CONCRETES—mechanical properties of pressure vessels of prestressed, effects of pressure and time on
FORT ST. VRAIN POWER REACTOR, UNIT 1—pressure vessel for, strain analysis for prestressed concrete
—fuel cycle for, analysis of optimum
—control elements of, calculation of withdrawal transients for
—fuel elements of, calculation of optimum flow configuration for
—fuel for, fabrication of phenolic resin-bonded carbon-coated particle-type
—blowers for, performance testing of bearings for helium
—boilers for, vibration testing of
GRAPHITE—tensile properties of conventional needle-coke, measurement of
HEAT TRANSFER SYSTEMS—flow distribution in Fort St. Vrain Power Reactor Unit 1, analysis of
HYDROGEN—sorption on Incoloy-800, Type-316 stainless steel, and chromium–molybdenum alloys, effects of time and temperature on
INCOLOY 800—sorption of carbon monoxide and hydrogen gases by, effects of time and temperature on
MOLYBDENUM ALLOYS AND SYSTEMS—Cr–Mo, sorption of carbon monoxide and helium gases by, effects of time and temperature on
NEUTRONS, FAST—effects on BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) fuel particles, analysis of
PRESSURE VESSELS—strain analysis of Fort St. Vrain Power Reactor Unit 1 prestressed concrete, description of
REACTIVITY—calculation of Fort St. Vrain Power Reactor Unit 1, effects of accidents on variation
REACTOR CONTROL ELEMENTS—withdrawal transients for Fort St. Vrain Power Reactor Unit 1, calculation of
REACTOR FUEL ELEMENTS—assemblies of Fort St. Vrain Power Reactor Unit 1, calculation of optimum flow configuration for
—radiation effects on fission product release in BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2), analysis of fast neutron
—fission product release rate from BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2), effects of annealing time and temperature on cerium-144, cesium-137, and strontium-89
REACTOR FUELS—fabrication of phenolic resin-bonded carbon-coated particle-type, methods for
REACTOR SAFETY—sorbent beds for Fort St. Vrain Power Reactor Unit 1 steam leak in helium coolant, performance requirements for
RESINS—use as binder in Fort St. Vrain Power Reactor Unit 1 carbon-coated particle-type of phenolic, description of
STAINLESS STEEL—sorption of carbon monoxide and hydrogen gases by Type 316, effects of time and temperature on
STRONTIUM ISOTOPES Sr-89—fission product release rate from irradiated BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle-type fuel, effects of annealing time and temperature on
THORIUM CARBIDES—ThC_2–UC_2, fuel cycle for Fort St. Vrain Power Reactor Unit 1, analysis of optimum
—ThC_2–UC_2, radiation effects on BISO-coated, analysis of fast neutron
—ThC_2–UC_2, fission produce release rate from BISO-coated fuels of, effects of annealing time and temperature on cerium-144, cesium-137, and strontium-89
URANIUM CARBIDES—ThC_2–UC_2, fuel cycle for Fort St. Vrain Power Reactor Unit 1, analysis of optimum
—ThC_2–UC_2, radiation effects on BISO-coated, analysis of fast neutron
—ThC_2–UC_2, fission produce release rate from BISO-coated fuels of, effects of annealing time and temperature on cerium-144, cesium-137, and strontium-89
VALVES—operating characteristics of Fort St. Vrain Power Reactor Unit 1 steam–water dump, evaluation of (D.C.C.)

9118 (GA-7634) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1966. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 20, 1967. Contract AT(04-3)-633. 154p. Dep. CFSTI.

BOILERS—testing of Fort St. Vrain Power Reactor Unit 1, analysis of vibration
CARBON MONOXIDE—sorption on Incoloy-800, Type-316 stainless steel, and chromium–molybdenum alloys, effects of time and temperature on
CHROMIUM ALLOYS AND SYSTEMS—Cr–Mo, sorption of carbon monoxide and hydrogen gases by, effects of time and temperature on
CONCRETES—mechanical properties of pressure vessels of prestressed, effects of temperature and time on
FISSION PRODUCTS—sorption by graphite of mixed, calculation of, (T)
FORT ST. VRAIN POWER REACTOR, UNIT 1—pressure vessel for, strain analysis of prestressed concrete
—core support structure for, performance testing of graphite
—fuel cycle for, analysis of optimum
—control elements for, effects of configuration on reactivity worth of
—core temperature distribution of, effects of refueling on
—core temperature distribution of, effects of control rod withdrawal accident on
—fuel for, fabrication of resin-bonded carbon-coated particle-type
—turbine for, testing of rotors for
—boilers for, vibration testing of
GRAPHITE—performance testing of Fort St. Vrain Power Reactor Unit 1 core support, analysis of
—tensile properties of conventional needle-coke, measurement of
—sorption of mixed fission products by, calculation of, (T)
HYDROGEN—sorption on Incoloy-800, Type-316 stainless steel, and chromium–molybdenum alloys, effects of time and temperature on
INCOLOY 800—sorption of carbon monoxide and hydrogen gases by, effects of time and temperature on
MOLYBDENUM ALLOYS AND SYSTEMS—Cr–Mo, sorption of carbon monoxide and hydrogen gases by, effects of time and temperature on
NEUTRONS, FAST—effects on BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) fuel particles, analysis of
PRESSURE VESSELS—strain analysis of Fort St. Vrain Power Reactor Unit 1 prestressed concrete, description of
REACTOR CONTROL ELEMENTS—reactivity worth of Fort St. Vrain Power Reactor Unit 1, effects of configuration on
—withdrawal accidents for Fort St. Vrain Power Reactor Unit 1, effects on core temperature distribution of
REACTOR FUEL ELEMENTS—radiation effects on BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle-type, analysis of fast neutron
—fission product release rate from BISO-coated thorium

carbide (ThC_2)–uranium carbide (UC_2), effects of annealing time and temperature on strontium-89
REACTOR FUELS—fabrication of resin-bonded carbon-coated particle-type, methods for
REACTOR SAFETY—sorbent beds for Fort St. Vrain Power Reactor Unit 1 steam leaks in helium coolant, performance requirements for
STAINLESS STEEL—sorption of carbon monoxide and hydrogen gases by Type 316, effects of time and temperature on
STRONTIUM ISOTOPES Sr-89—fission product release rate from irradiated BISO-coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle-type fuel, effects of annealing time and temperature on
THORIUM CARBIDES—ThC_2–UC_2, radiation effects on BISO-coated, analysis of fast neutron
—ThC_2–UC_2, fission product release rate from BISO-coated fuels of, effects of annealing time and temperature in strontium-89
TURBINES—rotor for Fort St. Vrain Power Reactor Unit 1, testing of
URANIUM CARBIDES—ThC_2–UC_2, radiation effects on BISO-coated, analysis of fast neutron
—ThC_2–UC_2, fission product release rate from BISO-coated fuels of, effects of annealing time and temperature in strontium-89 (D.C.C.)

9119 (JAERI–1164) FURNACE: THE TWO-DIMENSIONAL BURN-UP CODE FOR FAST REACTORS. Suzuki, Tomoo (Japan Atomic Energy Research Inst., Tokyo). May 1968. 18p. (In Japanese). Dep.

The code FURNACE has been developed for detailed study of burnup characteristics of fast reactors. The code solves two-dimensional diffusion equations on the CDC-3600 computer. The equations are solved by difference method. In order to meet requirements from thermal hydraulic calculation, detailed power distribution at each time step is needed. Neutron fluxes are obtained by an iterative method. The EQUIPOISE method is used in the code and coefficients of each mesh point are stored in the core memory (98K) so that a duplicate recalculation for the coefficients is not needed. The code can be used for criticality calculation without burnup. In burnup calculation, the treatments used in the code TORCH (JAERI-memo 2312) are engaged: the resonance self-shielding factors are recalculated whenever changes of atomic concentrations occur in due course of burnup or criticality adjustments. The one dimensional 26 group diffusion equations are solved for obtaining the neutron spectra to be used for deriving a few group constants in each region. At this stage criticality is maintained by adjustments of concentration of fuel, fertile or poison if necessary. At present the Russian set is used for calculations and the auxiliary code LTFURN has also been prepared for making library tape based on the Russian set. (auth)

9120 (JUL-Bibl.–14) THE HIGH-TEMPERATURE GAS-COOLED AND ADVANCED GAS-COOLED REACTORS. Literature Survey. (Kernforschungsanlage, Juelich (West Germany)). Sept. 1968. 702p. (In German and English).

Approximately 2000 references are cited on HTGR and AGR development and technology. Specific reactors examined include: AGR, AVR, DRAGON, Dungeness B, EBOR, Peach Bottom, Daniels Pebble Pile, German GHH II, Australian Pebble Bed Reactor, ORNL Pebble Bed Reactor Experiment, Fort St. Vrain, TARGET, THTR-Prototype, and UHTREX. Material is arranged by concept studies, reactor physics, components, structural materials, technology, fuels, fuel elements, fuel reprocessing, safety, and advanced studies. (H.D.R.)

9121 (NYO–3288-10) PERFORMANCE OF NUCLEAR REACTOR OPERATORS. Fitzpatrick, Robert; Dysinger, Dale W.; Hanson, Vernon L. (American Institutes for Research, Pittsburgh, Pa.). Sept. 1968. Contract AT(30-1)-3288. 173p. (AIR-491-9/68-FR). Dep. CFSTI.

The Reactor Operators Study was aimed at defining the functions and job requirements of nuclear reactor operators and developing a criterion measure of job performance of operators. An index of equipment operability was used to study operator requirements at various nuclear facilities. The critical incident technique was used to obtain 1400 reports of outstandingly effective and ineffective job performance of operators. From these data, lists of functions and of critical job requirements for operators were produced. A set of preliminary rationales was formulated, anticipating the possibility of later construction of predictor tests. In a series of steps, a Reactor Operator Performance Checklist was developed as the criterion measure of job performance. Using this Checklist, 82 supervisors and ten facilities observed and recorded the performance of 127 operators. Product-moment correlations between Checklist scores for two supervisors observing the same operator over two different time periods averaged about 0.40. The average correlation for single supervisors over two time periods was about 0.75. Relationships of Checklist scores with data such as age, experience, and test scores were generally quite low. The relationships were not altered substantially when variations in methods of scoring the Checklist were introduced. (auth)

9122 IMPROVEMENTS IN OR RELATING TO FLUID COOLED NUCLEAR REACTORS. Galletly, Roger Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,135,396. Dec. 4, 1968. Filed Aug. 5, 1965.

A downward coolant flow, pebble bed, nuclear reactor is described having a fissile pebble bed supported by, but spaced above, a base plate characterized by a disposition of coolant outlet ducts such that a downward flow of coolant through the bed changes to a transverse direction within the spacing between the bed and the baseplate. The bed is spaced from the base plate by a permeable refractory structure, so constructed that the coolant passes through the system without leaving dead zones which would overheat. The refractory structure is formed by a secondary or support aggregation of refractory particles of a neutron reflecting material or of a fertile material. Preferential coolant paths through the structure can be defined by having smaller bodies in the interstices of the secondary aggregation except where the preferential path is provided. The support aggregation can be extended upwards to provide a reflector surrounding the core aggregation. (UK)

9123 OUTLINE OF THE EXPERIMENTAL FAST REACTOR. Ichino, Ichiro (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo, 14: No. 9, 31-4(Sept. 1968). (In Japanese).

The second conceptual design for the experimental fast reactor to be developed in Japan has been transferred to PNC from JAERI. The main features include over-all output, 100 MW(t) (reactor core 92 MW(t) and blanket 8 MW(t)); fuel, PuO_2–UO_2 (20 and 80%, respectively); coolant, Na; control, ordinary control rods; and Na inlet temperature, 370°C, and outlet, 500°C. The experimental fast reactor is described. The state of development of fast reactors in Japan and in oversea countries is compared. Outline and purpose, main specifications, and the construction of the experimental fast reactor is described. The background and policy for the development of fast reactors are given. (NSA of Japan)

9124 NUCLEAR REACTOR. Hargoe, B. T. A. (to Aktiebolaget Atomenergi). Swedish Patent 217,071. Nov. 21, 1967. Filed Dec. 7, 1959. (In Swedish).

Described is a nuclear reactor with pressurized light or heavy water as coolant. The reactor vessel has one space for the core and one for pressure keeping. The two parts are separated by a plate with openings for liquid flow in both directions. The two spaces are approx. equal in size. The pressurized space is connected with a steam generator. (Swed.)

9125 THIRD SPECIAL REPORT FROM THE SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY. SESSION 1968–69. London, Her Majesty's Stationery Office, 1968. 10p. 1s. 9d.

Comprising ministerial comments on the recommendations contained in the Committee's Report on the UK Nuclear Reactor Programme, together with the Committee's replies. (UK)

9126 LIQUID-FUEL NUCLEAR-REACTOR-CORE WALL-AND-CHANNEL STRUCTURE. Gat, Uri; Schulze-Horn, Stephan; Vornhusen, Heinz (to Kernforschungsanlage Julich des Landes Nordrhein-Westfalen-e. V.). U. S. Patent 3,410,340. Nov. 12, 1968. Priority date June 2, 1965, Germany.

A wall-and-channel structure is described for liquid-fuel circulation nuclear reactor cores. Parallel plates define respective liquid-flow compartments and are interconnected by vertical edge bands bridging the longitudinal edges of the successive pairs of plates to maintain them in spaced relationship. The bands are contiguous to form a substantially continuous wall defining further compartments between the compartments defined by each pair of plates. An intermediate band bridges the plates to form upwardly and downwardly extending channels in the chambers between each pair of plates defining a respective compartment. When the reactor is provided with a breeder blanket, a continuous wall extends transversely to the plates along other longitudinal edges to form a partition between the plates and the continuous wall. (Offic. Gaz.)

9127 NUCLEAR THERMAL POWER PLANT. Frutschi, Hansulrich (to Escher Wyss Aktiengesellschaft). U. S. Patent 3,410,091. Nov. 12, 1968. Priority date Oct. 7, 1964, Switzerland.

Closed circuit gas turbine power plants utilizing heat generated in a nuclear reactor are described. Partial transfer of heat from

the reactor to the gaseous working medium is effected by passing partially or fully expanded working medium through the reactor. Additional heat transfer is effected by passing compressed or partially expanded working medium through one path of a surface heat exchanger which is located outside the reactor and which is provided with a second path through which working medium leaving the reactor is diverted back to the reactor inlet. (Offic. Gaz.)

9128 NUCLEAR POWER PLANT DESIGN. Kuljian, Harry A. New York, A. S. Barnes and Company, 1968. 283p. $30.00.

A guide for the design of nuclear power plants is presented for the mechanical, electrical, and structural engineers who are already familiar with conventional power system design. Chapters of the book are: Nuclear Reactor Components and Operation; Thermal and Hydraulic Problems in Nuclear Reactor Design; Remaining Calculations to Complete Conventional Part of a Nuclear Power Plant with BWR with Superheated Steam; Preliminary Design Drawings; Major Items of Machinery; and Nuclear Fuels and Material Components. Applicable tables and charts are included. The types of systems covered are: boiling water reactor with saturated steam, boiling water reactor with superheated steam, pressurized water reactor, heavy water reactor, gas cooled reactor, organic cooled and moderated reactor, sodium cooled graphite moderated reactor, and sodium cooled fast reactor. (M.L.S.)

9129 GENERAL ADMINISTRATIVE ACTIVITIES. Blakely, J. P. (comp.). Nucl. Safety, 10: 105-7(Jan.-Feb. 1969).

Commissioner Ramey's comments on the evolution of the regulatory process are excerpted. Efforts toward the nuclear power–desalting project are summarized. The LMFBR plan is summarized. (M.L.S.)

Kinetics and Dynamics

9130 (ANL-7476) THE EBR-II FEEDBACK FUNCTION. Hyndman, R. W.; Nicholson, R. B. (Argonne National Lab., Ill.). July 1968. Contract W-31-109-eng-38. 56p. Dep. CFSTI.

An attempt was made to deduce as much information as possible on the EBR-II feedback function from a series of oscillator and rod-drop experiments. Because of weak feedback and deficiencies in the experimental equipment, the results may contain significant errors. The accuracy and consistency of the feedback function estimates are discussed, and improvements for future experiments are suggested. (H.D.R.)

9131 (EURFNR-533) GROUP CONSTANTS FOR STEAM- AND SODIUM-COOLED FAST REACTORS (26-GROUP REPRESENTATION). Huschke, H. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-770. 126p. (EUR-3953). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

A 26-group spectrum obtained by using the Russian ABN-Karlsruhe KFK-26-10 group sets is applied to establish the collision density spectrum for steam-cooled fast reactors. The 26-group set is designated KFK-SNEAK. The group constants for the isotopes H, C, O, Na, Al, Cr, Fe, Ni, ^{235}U, ^{238}U, and ^{239}Pu are recalculated and presented. When applied to liquid sodium-cooled reactors, the KFK-NAP set is formed. (D.C.C.)

9132 COMPUTATION AND USE OF HOT-CHANNEL FACTORS. Sanders, J. P. Nucl. Safety, 10: 28-37(Jan.-Feb. 1969).

Hot-channel factors are used to relate the average or nominal development of temperatures in nuclear reactors to those temperatures developed as a result of minor variations in fabrication, operation, or other perturbations from the design conditions. Historically, these factors may include the nuclear factors that affect the maximum-to-average power density ratio in the core plus those factors which indicate the deviations from normal engineering design, or they may contain only the engineering components. In this latter case they can be more properly termed "engineering factors," which is the current practice. The engineering components may include flow maldistribution, irradiation effects, fabrication and enrichment tolerances, intersubchannel mixing, and flow redistribution within the fuel assembly due to geometrical design or power gradients. Several methods of combining these factors on a statistical basis have been proposed in recent years. Rude and Nelson have suggested that each effect can be represented by a normal distribution function, whereas Abernathy began with a step function and produced a statistically distributed result. Regardless of the calculational method, consideration must always be given to the limiting operating criteria in applying the results. 21 references. (auth)

Control Systems

9133 CONTROL SYSTEM FOR LARGE REACTORS. MacKay, Ian Norton (to General Electric Co., Ltd.). U. S. Patent 3,406,091. Oct. 15, 1968. Filed Dec. 12, 1966.

A pressure tube thermal power nuclear reactor with individual power zones is described. Each power zone has a separate coolant circuit provided with reactivity suppression means permitting at least partial shut down of a selected zone. Booster means within the reactor adjacent the shut down zone compensate for the loss of neutron activity from that zone to maintain effective production of thermal power in the adjacent zones. (Offic. Gaz.)

9134 DEVICE FOR CONTROLLING THE REACTIVITY OF A NUCLEAR REACTOR. Margen, Peter Heinrich Erwin (to Aktiebolaget Atomenergi). U. S. Patent 3,406,092. Oct. 15, 1968. Priority date Dec. 20, 1963, Sweden.

A device for controlling the reactivity of the nuclear reactor having a forced upward coolant circulation is described. The device consists of at least one tube extending partly in the core and partly above the core. The tube contains at least one neutron absorbing body freely movable up and down in the tube with the lower end of said tube being open into the reactor and the upper end of the tube being closed. A side conduit connects to the tube at a location between the ends of the tube, and the free end of the side conduit is connected to a zone in the circulation system of the reactor having a lower pressure than that of the zone to which the open lower end of the tube is connected. The side conduit contains a variable restriction for controlling the rate of fluid flow. (Offic. Gaz.)

9135 REACTIVITY CALIBRATIONS BY ANALOG AND DIGITAL METHODS USED DURING ESSOR ZERO POWER EXPERIMENTS. Dierckx, R.; Hage, W.; Hettinger, H.; Ligou, J.; Martinet, M. (EURATOM, Ispra, Italy). Atomkernenergie, 14: 17-21(Jan.-Feb. 1969).

Control rod calibrations performed with an analog and digital method are described. The obtained experimental reactivity values are compared with theoretical calculations. (auth)

9136 UPRAVLENIE YADERNYMI ENERGETICHESKIMI USTANOVKAMI. (Nuclear Power Plant Control). Filipchuka, E. V. Moscow, Atomizdat, 1968. 136p.

Eleven articles are included on the control and operation of nuclear power installations. Space energy release in a reactor and neutron field control are analyzed in order to determine the optimum economic indexes for nuclear reactor start up and operations. Optimization of transition process in the IGR (impulse graphite reactor) developed by a computer and problems of reactor trained personnel are discussed. Design and construction models of experimental reactors, and a simplified model of the primary circuit heat exchanger are described. Analysis is given of diode tubes for logarithmic calculations. Graphs for automatic control and personnel protection are also included. 57 references. (R.V.J.)

Shielding

9137 PLASTIC CONCRETE IN NUCLEAR POWER PLANTS. Milaszewski, Edward. Tek. Tidskr., 98: 831-2(1968). (In Swedish).

Mechanical properties are given for plastic concrete made of polyester plastic and barytes. Its use as shielding materials in nuclear reactor plants is briefly described. (Swed)

Cooling Systems

Refer also to abstracts 7690 and 7910.

9138 (LA-DC-9666) INTEGRAL FULL-FLOW VACUUM DISTILLATION SAMPLING SYSTEM FOR USE IN A HIGH TEMPERATURE RADIOACTIVE SODIUM ENVIRONMENT. Rutkauskas, V. J. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 15p. (CONF-681106-3). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

A laboratory model integral full-flow vacuum distillation sampling system is currently being used at the Los Alamos Scientific Laboratory for the routine analysis of O_2 in experimental dynamic Na systems. This analytical method has a precision of ±0.5 ppm in the O_2 concentration range of 1 to 10 ppm and the time required for a completed analysis is approximately 2 hours. The design of the laboratory system is being modified to enable it to be used in a radioactive Na environment at LMFBR temperature conditions. The entire system is constructed of Type

304 stainless steel and the separation of Na from the nonvolatile impurities is accomplished with a high frequency induction generator is located within the metal envelope of the distillation zone. The system design eliminates the need for sample transfer, thereby eliminating potential atmospheric contamination. The Na distillate is retained in a combination condenser and reservoir. A remotely operated sampling system will be installed in the EBR-11. The full-flow vacuum distillation sampling system is designed for the routine removal of Na samples for O_2 analysis and it has the potential for being used to identify other species present in a radioactive Na environment. (auth)

9139 LIQUID-COOLED NUCLEAR REACTOR. Gollion, Henri-Jacques (to Commissariat a l'Energie Atomique). British Patent 1,135,974. Dec. 11, 1968. Priority date Dec. 23, 1966, France.

HEAT TRANSFER SYSTEMS—liquid metal-cooled closed cycle core and heat exchanger fast reactor, description of
REACTORS, FAST—cooling system for liquid metal-cooled, description of closed cycle core and heat exchanger
REACTORS, LIQUID METAL-COOLED—cooling system for fast, description of closed cycle core and heat exchanger (D.L.C.)

9140 HEAT EXCHANGERS. (to Sulzer Brothers Ltd.). British Patent 1,135,433. Dec. 4, 1968. Priority date Jan. 21, 1965, Switzerland.

HEAT EXCHANGERS (GAS-GAS)—gas-cooled reactor multiple parallel tube-bend-connected finned-tube, description of
REACTORS, GAS-COOLED—heat exchanger for carbon dioxide description of gas–gas parallel tube-bend-connected finned-tube

9141 NUCLEAR REACTOR AND SURROUNDING STEAM GENERATOR. Kaegi, Jakob (to Sulzer Brothers, Ltd.). U. S. Patent 3,413,194. Nov. 26, 1968. Priority date Feb. 23, 1966, Switzerland.

The nuclear reactor plant pressure vessel houses a steam generator and a nuclear reactor in spaced relation with separating walls between the reactor and wall of the pressure vessel to define a flow duct for the reactor coolant. The coolant flows through the reactor and through the steam generator in a closed cycle. (Offic. Gaz.)

9142 INTEGRAL STEAM GENERATOR AND NUCLEAR REACTOR COMBINATION. Ammon, Johannes H.; Schlichting, John; Sprague, Theodore S. (to Babcock and Wilcox Co.). U. S. Patent 3,401,082. Sept. 10, 1968. Filed May 24, 1966.

An integrally packaged steam generator and nuclear reactor combination in which the reactor core is contained within an inner pressure vessel, and steam generation takes place in an annular chamber defined by the outside surface of the inner pressure vessel and the inside surface of an outer pressure vessel disposed in laterally surrounding spaced-apart relation to the inner pressure vessel is described. Primary coolant is circulated by a pump in a closed cycle path in which coolant delivered at the pump outlet is introduced into the inner pressure vessel, flows through the reactor core, leaves the inner pressure vessel and flows through tubes extending within the steam generation chamber, and after exiting the tubes, is returned to the pump inlet for continuous circulation. (Offic. Gaz.)

9143 FAST NUCLEAR REACTOR COOLED BY SUPERCRITICAL STEAM. Barker, Allan (to United Kingdom Atomic Energy Authority). U. S. Patent 3,409,502. Nov. 5, 1968. Priority date Feb. 11, 1963, Great Britain.

A fast nuclear reactor cooled by steam at supercritical pressure is described. Features of the reactor include a heat rating of not less than 8 MW per cubic foot of core; heat transfer surface area of at least 80 square feet per cubic foot of fuelled core; cylindrical, elongated fuel elements, preferably sheathed ceramic fuel, of approximately diameter 0.2 inch; and a temperature rise of coolant across the core of less than 200°C. A power plant including the core and an arrangement for dividing the coolant from the core into two streams, one of greater mass flow for supplying heat to a reheater and the other stream of lesser mass flow for driving a turbine, is described. (Offic. Gaz.)

9144 IMPROVEMENTS RELATING TO HEAT EXCHANGERS. (to Sulzer Brothers Ltd.). British Patent 1,135,434. Dec. 4, 1968. Priority date Jan. 21, 1965, Switzerland.

HEAT EXCHANGERS (GAS-GAS)—reactor tube-bend-connected multiple parallel finned-tube, description of gas-cooled reactor
REACTORS, GAS-COOLED—heat exchanger for, description of tube-bend-connected multiple parallel finned-tube (D.C.C.)

9145 IMPROVEMENTS IN AND RELATING TO A NUCLEAR INSTALLATION. Lecomte, Jacques; Weil, Louis (to Commissariat a l'Energie Atomique). British Patent 1,137,298. Dec. 18, 1968. Priority date May 16, 1966, France.

HEAT TRANSFER SYSTEMS—description of liquid metal-cooled reactor steam circulating pipes in double-wall core-containing liquid sodium
REACTORS, LIQUID METAL-COOLED—cooling system for, description of steam circulating pipes in double-wall core-containing liquid sodium (D.C.C.)

9146 A DEVICE FOR REGULATING THE RATE OF COOLANT FLOW THROUGH A NUCLEAR-REACTOR FUEL ELEMENT. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,135,925. Dec. 11, 1968. Priority date Feb. 17, 1965, Germany.

HEAT TRANSFER SYSTEMS—superheating reactor, description of thermal expansion-actuated fuel channel plug in
REACTORS, SUPERHEATING—cooling system for, description of thermal expansion-actuated fuel channel plug in
VALVES—thermal expansion-actuated fuel channel plug, for superheating reactors (D.C.C.)

9147 EQUIPMENT FOR A BOILING WATER REACTOR. Wadmark, L. O. T. (to Aktiebolaget Atomenergi). Swedish Patent 211,282. Feb. 28, 1967. Filed June 25, 1964. (In Swedish).

Equipment is described for spray cooling of a reactor fuel canned in a vertical tube. The upper part of the tube opens for steam outlet. The cooling water inlet consists of a cylindrical, moveable head with a multi-hole nozzle. (Swed)

9148 GAS COOLED NUCLEAR REACTOR. Dell, John D. (to Babcock and Wilcox Ltd.). U. S. Patent 3,410,752. Nov. 12, 1968. Priority date June 22, 1965, Great Britain.

A gas cooled nuclear reactor is described having a concrete wall and multiple heat exchangers fitted in penetrations in the wall from the outer surface. The penetrations form mouths in the outer surface of the wall through which the exchangers are passed for fitting within the penetration. Each penetration mouth is closed by a closure mounted on the exchanger that also acts as a head for the exchanger. A circulating fan is mounted in a wall cavity for circulating primary coolant through each heat exchanger while secondary coolant is circulated once through the exchanger. A layer of spent primary coolant intermediate the exchanger and penetration wall is provided for insulating purposes. A centrifugal circulating fan is included, and helically coiled reheater coils are carried by the closure for first heating incoming primary coolant. (Offic. Gaz.)

9149 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR COOLANTS. Feates, Francis Stanley; Sach, Roger Stuart (to United Kingdom Atomic Energy Authority). British Patent 1,137,483. Dec. 18, 1968. Filed Dec. 17, 1964.

A method is described for reducing the radiation induced CO_2–graphite reaction in gas-cooled reactors by use of a selected additive to the gas. The additive may be azomethane, acetone, acetyl acetone, acetaldehyde, diacetyl, diethyl ether, tetramethyl silane, trimethylamine, xylene, t-butyl peroxide, toluene, trimethyl benzene, ketene, diketene, diazomethane, ethylene oxide, dichloromethane, or acetylene, present at a concentration of 200 to 300 vol. ppm. (UK)

9150 NUCLEAR REACTORS. Shaw, James William Westgarth; Coast, Geoffrey; Broidy, Ronald Francis; McLaren, Norman Harold; Tinsley, Peter Hugh (to United Kingdom Atomic Energy Authority). British Patent 1,137,279. Dec. 18, 1968. Filed Nov. 28, 1966.

An arrangement for a gas-cooled graphite-moderated reactor is described with improved alignment between the fuel channels and the standpipe to reduce the need for free space and articulation of the stringers. The reactor has a core structure comprising an array of solid moderator blocks, a concrete pressure vessel enclosing this array, fuel element stringers each carried in an axial channel through a moderator column, and an outer shroud for each channel. Support means at one axial end of the core structure defines a coolant inlet plenum, and a member at the other axial end of the core structure defines a further coolant inlet plenum and on its other side a coolant outlet plenum. (UK)

9151 VAPOR-COOLED REACTOR SYSTEM. Schluderberg, Donald C.; Winders, Gordon R.; Dossett, John (to Babcock and Wilcox Co.). U. S. Patent 3,414,473. Dec. 3, 1968. Filed Oct. 3, 1966.

The nuclear reactor comprises a containment vessel occupied by a reactor vessel containing a cylindrical shell in its upper portion and a vapor separating chamber in its lower portion. The shell encloses a nuclear core, is fitted with circulators forcing vapor through the core, and cooperates with the reactor vessel to provide a vapor flow path from the separating chamber to the

circulators. Vapor from the separating chamber is directed to the circulators and forced through the core wherein it is superheated. Part of the superheated vapor is directed to a prime mover and another part to a desuperheater wherein its excess heat is used to evaporate feedwater which is supplied at a rate in excess of the total vapor demand. The resulting saturated vapor is directed to the separating chamber and thence to the circulators. (Offic. Gaz.)

Fuels

Refer also to abstracts 7649, 7692, 7711, 8254, 8276, 8293, 8294, 8349, and 8352–8355.

9152 (AAEC/E–193) DEVELOPMENT OF STAGE I BERYLLIA, FUELLED BERYLLIA, AND SPHERICAL BERYLLIA-BASED FUEL ELEMENTS FOR THE HIGH-TEMPERATURE GAS-COOLED REACTOR FEASIBILITY STUDY. Reeve, K. D.; Ramm, E. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1968. 43p. Dep.

Requirements of BeO for use as moderator, fuel matrix, and fission-product-retentive coating in an all-ceramic, dispersion-type fuel element for use in a High Temperature Gas-Cooled Reactor are discussed. Reasons for choosing Brush UOX BeO powder, and isostatic pressing for fabricating it, are given. The characteristics of this powder, and the effects of many fabrication variables on the properties of the sintered product, are discussed in detail. A process was chosen for producing an interim standard sintered BeO, to be known as Stage I BeO. The properties of Stage I BeO are presented, and suggestions are made for improvement of both the material and the fabrication process. Some discussion is included on the extension of this work to the fabrication of fueled BeO and of BeO-based spherical fuel elements. (auth)

9153 (BAW–3867–5) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, July–September 1968. Jacobsen, J. A.; Roy, D. H.; Stewart, J. E.; Tilford, J. M. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Nov. 1968. Contracts AT(30-1)-3867; 859-3105. 60p. Dep. CFSTI.

A description of the FARED computer program overlay structure is presented. Depletion calculations are included for 2000 and 8000 liter fast breeder reactor cores using three combinations of cross-section data. The generalized refueling scheme is described. (D.C.C.)

9154 (CEA–R–3618) THE CYRANO PROGRAM. I. DESCRIPTION AND OPERATION OF AN IRRADIATION DEVICE CYRANO. II. RESULTS OF THE CYRANO I AND II EXPERIMENTS; STUDY OF THE EL 4 FIRST-CORE RODS; MEASUREMENT OF THE THERMAL CONDUCTIVITY INTEGRAL UP TO 2300°C FOR UO_2 SINTERED; EVOLUTION OF FISSION GASES AT CONSTANT POWER. Stora, Jean-Pierre; Chenebault, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 114p. (In French). Dep.

Two rods of the type in the EL 4 first charge were irradiated in "Cyrano" capsules which are suited for continuous measurement of the nuclear power evolved and equipped with thermocouples. The variations of the integral of conductivity of sintered 96% theoretical density UO_2 were measured to 2300°C; these variations are consistent with those previously measured out-of-pile. The released fission gases were recovered at different times during the irradiation. The kinetics of release of stable gases is such that the fraction of released gases is still widely increasing after 12 days of irradiation. Numerous observations were made on local concentrations of rare gases in the irradiated fuel. (auth)

9155 (EUR–4070) FORCED CONVECTION BURNOUT AND HYDRODYNAMIC INSTABILITY EXPERIMENTS FOR WATER AT HIGH PRESSURE. PART V. ANALYSIS OF HEATING AND BURNOUT EXPERIMENTS IN A DOUBLE CHANNEL TEST SECTION, WITH TRANSVERSELY VARYING HEAT GENERATION. Pozzi, G. P.; Previti, G.; Sala, P. (FIAT, Turin (Italy). Sezione Energia Nucleare). July 24, 1968. 114p. Dep.

The analysis of some heating and burnout tests performed in a double channel test section has been performed. The calculation method used was a digital program that solves the mass, energy and momentum equations of a mono- (or two) phase fluid in a tridimensional domain. First some heating tests with no bulk boiling have been analyzed: the calculation outlet temperature distribution in the various subchannels has been compared with the experimental outlet temperature distribution. Next a systematic analysis of the burnout tests has been performed, with different heating on the burnout rod, on the adjacent rod and on the shell. (auth)

9156 (GA–8524) RETENTION OF IODINE BY PYROLYTIC-CARBON-COATED NUCLEAR FUEL PARTICLES. Langer, S.; Adams, C. C.; Anderson, E. E.; Graves, J. N.; Yamaguchi, T. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 6, 1968. Contract AT(04-3)-633. 9p. (CONF-680308–13). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

The retention of fission-product iodine by pyrolytic-carbon-coated $(Th,U)C_2$ fuel particles has been studied in annealing experiments at 1100° and 1300°C. The objective was to measure the low release rates from the particles and to obtain a material balance between the measured release and the inventory in the particles. The study was carried out on control (lightly irradiated to $\sim 10^{13}$ fissions) particles and on highly irradiated particles. The specimens (20 to 5000 fuel particles) were activated to produce short-lived Xe and I, and the releases were studied in annealing experiments at 1100° and 1300°C for 15 hours. The fission gases released were collected in liquid-nitrogen-cooled charcoal traps, which were gamma counted to determine the amounts released. For the unirradiated particles, the release of ^{135}Xe was $<10^{-5}$ and ^{133}I was $<10^{-4}$. For the highly irradiated particles, essentially no release was detected at the end of the 15 hours; therefore, the temperature was raised to 1600°C so that a limit could be placed on the release. Particles with 8.5% heavy metal burnup released $<4.4 \times 10^{-5}$ of the ^{135}Xe and $<7.5 \times 10^{-4}$ of the ^{133}I at 1300°C. At 24% burnup the releases were $<5.6 \times 10^{-5}$ and $<5.8 \times 10^{-4}$, respectively, at 1600°C. After 12 days' delay, all of the ^{133}I ($t_{\frac{1}{2}}$ = 21 hours) had decayed to ^{133}Xe and the particles were burned at 1000°C to obtain a material balance for the iodine. The effluent gases were collected in a cold trap which was counted for ^{133}Xe. The material balance experiment showed that 95% of the ^{133}Xe was present, which, within experimental uncertainty, is tantamount to quantitative retention. (auth)

9157 (KFK–808) CALCULATIONAL METHOD FOR DESCRIBING THE WEAKENING OF FUEL CANS IN LIQUID METAL COOLED FAST REACTORS. Schmidt, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). July 1968. 131p. (In German). (EUR–3968). Dep.

The bases for theoretical treatment of creep reactions of fuel element cladding material with flowing liquid Na are given. The equations describing the creep effects are developed. Numerical techniques used for solving the equations are described. Stress limits for the cladding tubes are derived; thermal racheting criteria are developed for the general case. The mathematical model for determining the radial swelling rate is given; the flow diagram for computer solution to the equations is given. 26 references. (M.L.S.)

9158 (ORNL-TM–2373) BUBBLES, DROPS, AND ENTRAINMENT IN MOLTEN SALTS. Kohn, H. W. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

The production and behavior of drops from splashes and bubbles are reviewed and described. Possible application of these phenomena to the MSRE pump bowl is considered. There are three sorts of drops which can contribute to entrainment in the MSRE, jet drops from splashes and from small recirculated bubbles, film drops from the breakup of the film cap of larger bubbles, and crown drops from the breakup of the crown from splash drops. In addition, there might be a considerable direct aerosol formation due to spray from the spray ring. The amount of salt available for entrainment from these sources is much larger than that actually lost from the reactor, hence most of the droplets must be returned somehow to the liquid stream. Jet drops can preferentially remove a surface film from a molten salt surface. This surface microtome effect may well be contributing to the apparent loss of fission products to the gas stream. (auth)

9159 (ORNL-TM-2393) COMPUTER PROGRAM FOR HANDLING AND COMPARING FISSION PRODUCT DATA FROM RIBDOR FOR MIXTURES OF REACTOR FUELS IRRADIATED UNDER DIFFERENT CONDITIONS: APPLICATION TO ATOMICS INTERNATIONAL LMFBR FUEL. Davis, W. Jr.; Soard, H. F. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Summarized are the methods for handling output from the RIBDOR program for calculating grams, gram-atoms, curies, β power, and γ power of fission products as a function of burnup and out-of-reactor decay time. Two programs—a modified RIBDOR program to punch the desired data, and a program to handle the cards—are required. The data-manipulating program provides for combining (as in an aqueous dissolution step) specified quantities of various types of fuel and comparing the resulting fission product quantities with those for any reference reactor. Detailed tables of data are presented for solutions derived from Atomics International LMFBR fuel for decay times of 30

days to 100 years. A detailed tabular comparison shows that the total amount of radioactivity (curies, β power, γ power) present in such a solution, containing 65.1 g of (U + Pu) at 30 days out-of-reactor, is very similar to that found in a solution obtained from a conceptual reference reactor fuel (an advanced LWR fuel irradiated to a burnup of 40,000 MWd/metric ton), containing 300 g of U, at 150 days out-of-reactor. (auth)

9160 (UJV–2023–R) THERMAL CALCULATIONS OF FUEL ELEMENT RODS. Pecha, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1968. 41p. (In Czech). Dep.

A method for performing thermal calculations for a fuel element consisting of concentric tubes with smooth or longitudinally finned surfaces is described. The geometry of the fuel element and the density distribution of heat sources in the fuel element are assumed as given and an iterative method of calculation is then used. The length of the element is divided into a certain number of parts and the temperature of the cooling gas, the surface temperature and the maximum temperature in the U tube are determined for each dividing plane. Descriptions of a program compiled in GIER-ALGOL language, the input tapes, and print-out results are included. (auth)

9161 HYDRAULIC HOLDDOWN FOR NUCLEAR REACTOR FUEL ASSEMBLY. Menzel, Gerhart; Klotz, Charles E. (to Allis-Chalmers Mfg; Co.). U. S. Patent 3,401,081. Sept. 10, 1968. Filed Apr. 28, 1966.

A nuclear reactor fuel assembly is described which has a hydraulic holddown characteristic effected by an inlet nozzle at the lower end of the fuel assembly. The nozzle is provided with a plurality of inlet orifices perpendicular to the longitudinal axis of the fuel assembly to initially admit coolant perpendicular to the longitudinal axis of the fuel assembly. Coolant passageways then divert the incoming coolant upward parallel to the longitudinal axis of the fuel assembly. In the reactor, the fuel assembly is supported by a cup shaped support member which receives the nozzle. The cup shaped support member is provided with a plurality of openings which mate with the openings into the nozzle. (Offic. Gaz.)

9162 FUEL OR FERTILE ELEMENT FOR NUCLEAR REACTORS. Boettcher, Alfred (to Kernforschungsanlage Julich Gesellschaft mit beschrankter Haftung Nordrhein-Westfalen-e.V.). U. S. Patent 3,413,195. Nov. 26, 1968. Priority date June 29, 1965, Germany.

Fuel or fertile element for a nuclear reactor core having a hermetically sealed metallic (Zircaloy) shell is described. The shell contains a loosely piled mass of coated particles having substantially uniformly spherical core with a diameter of 50 to 500 microns and a fuel or fertile substance. A coating of pyrolytic graphite, BeO, Al_2O_3, MgO, ZrO_2, ZrC, SiC, or NbC, surrounds the core and has a thickness of 50 to 150 microns. The particles have an irregular outer configuration with a plurality of generally flat surfaces. He, at least at atmospheric pressure, constitutes an inert gas filling. The shell has a generally cylindrical annular compartment receiving the coated particles. (Offic. Gaz.)

9163 IMPROVEMENTS RELATING TO TUBULAR NUCLEAR FUEL RODS. Swanson, Kenneth MacGregor; Gatley, John Andrew (to United Kingdom Atomic Energy Authority). British Patent 1,135,235. Dec. 4, 1968. Filed May 11, 1965.

A tubular nuclear fuel rod is described having inner and outer sheaths with fuel between them. One sheath has a termination in axially sliding relationship with the other, to provide along the opposing wall surface of the latter a vent path to the exterior of the fuel rod for gases released in the fuel. The sheaths are rigidly fixed together only in one region of the rod, remote from the termination, so as to allow differential thermal expansion. In the simplest form either the inner sheath is flared or the outer sheath is pinched, to produce as the termination a free edge which is unconnected with the outer sheath. It may be desirable (e.g., with fuel containing plutonium) to manufacture the rod with a thermally destructible seal closing the vent path. Details are given of a fuel rod for use in a liquid sodium-cooled fast reactor. (UK)

9164 NUCLEAR REACTOR FUEL ELEMENTS. Swanson, Kenneth MacGregor (to United Kingdom Atomic Energy Authority). U. S. Patent 3,409,503. Nov. 5, 1968. Priority date June 23, 1966, Great Britain.

A fast nuclear reactor fuel element has sheathing forming internal and external walls, both being exposed to the same flowing coolant. Ceramic nuclear fuel is contained in the sheathing and is less than theoretical density to provide distributed voidage. A layer of thermal insulating material is located between the fuel and the inner face of the external wall, the fuel contacting the inner face of the internal wall closely, whereby the operating temperature of the fuel adjacent the insulating layer is raised compared with that of the fuel adjacent the internal wall. This lowers the compressive creep resistance of the portion of fuel operating at higher temperature and induced swelling is absorbed in the distributed voidage of the fuel. The concept is particularly applicable to the case where the external wall of the sheathing is a shell and where coolant tubes within the shell form the internal wall of the sheathing. (Offic. Gaz.)

9165 FUEL ELEMENT FOR NUCLEAR REACTOR. Hargoe, B. T. A. Swedish Patent 216,529. Oct. 31, 1967. Filed Mar. 9, 1962. (In Swedish).

A fuel element is described for use in nuclear reactors cooled and moderated by heavy water. The element consists of two coaxial circular tubes, one placed in the other. The fuel is made of rods that are placed in the ring-formed space between the two tubes. Part of the space is used as cooling channels. In the tubes there are openings for the coolant inlets and outlets. The space length is divided by horizontal rings. These are fixed by bars in the space between the inner and outer tube. (Swed)

9166 MONTE CARLO CALCULATIONS (ONE-GROUP) OF $^{238}U/^{235}U$ FISSION RATIOS IN ROD-CLUSTER FUEL ELEMENTS. McCulloch, D. B.; Doherty, G.; Hesse, E. W. (Australian Atomic Energy Commission Research Establishment, Sydney). J. Brit. Nucl. Energy Soc., 7: 307-12(Oct. 1968).

A one-energy group Monte Carlo collision probability code (MONTE) was written to calculate the ratio of $^{238}U/^{235}U$ fission ratios in rod-cluster geometry. A reasonably exact representation of the lattice cell was adopted, with a simplified representation of neutronic events. The predictions of the code were compared with experimental data for UO_2 rod-cluster fueled heavy water reactor lattices with a number of different coolants. Using a single fixed set of cross-section data, the variation of δ_{28} with coolant type and lattice pitch was satisfactorily predicted, but the situation with regard to cluster geometry variations was less clear. For the only "small" cluster (seven rods) for which experimental data were available, there was very close agreement between experiment and theory. For the larger clusters (19 or more rods), more typical of practical power reactors, the MONTE predictions were on average some 8% lower than experiment. It was not resolved whether this cluster geometry effect arises from shortcomings of the MONTE model or from a systematic bias in the experimental data. (auth)

9167 FUEL MANAGEMENT METHODS FOR PEBBLE BED REACTORS, AND THEIR APPLICATIONS TO THE AVR. Giesser, W.; Jung, H.; Massimo, L. (Brown, Boveri/Krupp, Mannheim, Ger.). Atomkernenergie, 14: 43-6(Jan.-Feb. 1969).

Calculational methods for pebble bed reactor fuel management are described, taking into account the flow properties of the balls. These methods have been used for the calculation of the AVR fuel management under different assumptions about the loading schemes. (auth)

9168 A SIMPLIFIED THEORETICAL APPROACH TO DOUBLE SIDED COOLING OF A TUBULAR FUEL ELEMENT BY BOILING AND SUPERHEATING. Zdravkovich, M. (Belgrade Univ.); Kondich, N. Atomkernenergie, 14: 35-42(Jan.-Feb. 1969).

A tubular fuel element cooled outside by boiling water and inside by dry steam is represented by a simplified mathematical model. Thermodynamic relations are used to derive the necessary equations which lead to two simultaneous systems of differential equations for the three unknown functions: temperature distribution of the subcooled water and dry steam and the variation of the steam content, all along the height of the fuel element. The coefficients in these equations depend on various thermodynamic and thermophysical quantities taken as parameters. An analog computer technique is utilized to analyze the effect of various parameters on the coolant temperature at a fixed geometry of the fuel element. An analytical discussion is presented for the case of fixed parameters and varying geometry, which revealed the limits of the radii ratio of the tubular fuel element from the point of view of practical application. (auth)

9169 BWR BURN-OUT EXPERIMENTS. Rolstad, E.; Kjaerheim, G. (OECD Halden Reactor Project, Norway). Nucl. Eng. Int., 13: 1021-7(Dec. 1968).

The results are reported of experiments involving the use of four different detector systems to map the critical heat transfer condition on six different test assemblies with natural and forced convection cooling. The principles used in the burnout detectors were thermocouple temperature measurement at an artificially induced hot spot, variation of the insulation of a cable embedded in axial grooves in the fuel surface, fuel elongation measurement by differential transformer, and variation of the cladding resistance. Critical conditions were approached either by increasing the power or by reducing the coolant flow. On the basis of the results a burnout mechanism is proposed, and the detector sys-

tems used are compared. Burnout prediction and monitoring are discussed, and their influence on design is considered. (UK)

Auxiliary and Emergency Systems

Refer also to abstract 8168.

9170 (CEA-CONF-1033) STUDY OF AN INTEGRATED HEAVY WATER REACTOR COOLED BY CARBON DIOXIDE GAS. Fonteray, J.; Martin, R.; Roche, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 11p. (In French). (CONF-680525-7). Dep.

From ENEA Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Paris, France.

The advantages of integrated circuits in gas cooled graphite moderated reactors are discussed. The safety of integrated designs is considered; the variations in general arrangement of the core are described. Problems with the integrated design are outlined. A cross section of a typical integrated reactor design is shown. (M.L.S.)

9171 PRESSURE SUPPRESSION SYSTEM FOR NUCLEAR REACTOR PLANTS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,135,826. Dec. 4, 1968. Priority date Apr. 13, 1965, Sweden.

REACTORS, SUPERHEATING—pressure suppression system for, description of spray-cooled stone-packed
SPRAY COOLING SYSTEMS—description of superheating reactor stone-packed pressure-suppressing (D.C.C.)

9172 NUCLEAR REACTOR FUEL HANDLING SYSTEMS. Burton, John Cornelius; Walker, Desmond John; Wallis, Eric (to English Electric Co., Ltd.). British Patent 1,136,251. Dec. 11, 1968. Filed Jan. 11, 1965.

A fuel handling system for gas-cooled reactors is described, which may be used for both on-load and off-load operation. The system comprises a transport flask in the form of a transportable pressure vessel with a lid having at least one aperture for the passage of fuel elements, and an assembly for coupling the access duct of the reactor sealably to the flask lid. The flask contains a rotatable magazine including at least one ring of longitudinally extruding magazine tubes for holding fuel elements. The hole in the lid of the transport flask may be closed by a plug, which is removable into a plug storage tube constituting one of the magazine tubes. The flask includes a capping device mounted on its lid. (UK)

9173 DETECTION OF INCIPIENT FAILURES IN PRESSURE VESSELS BY STRESS-WAVE EMISSIONS. Green, A. T. (Aerojet-General Corp., Sacramento, Calif.). Nucl. Safety, 10: 4-18 (Jan.-Feb. 1969).

Advances in stress-wave emission techniques for detecting and monitoring failure processes in engineering materials have created considerable interest in their application in systems that will foretell incipient failure of a pressure vessel. Programs on various aspects of the technology are being carried out in a relatively small, but rapidly growing, number of development laboratories. These programs range from pure research into the basic phenomena, such as in materials evaluations programs, to the development of environmentally hardened sensors and the fabrication and use of application hardware and systems. Source location of the stress wave has been demonstrated as being within the capability of present technology. Resolution of the severity of the located defect has not been completely accomplished, although significant progress has been made toward this objective. The in-place, continuous surveillance nature of the technique enhances its value, since operational requirements of a nuclear pressure vessel greatly impede the use of the usual inspection techniques. Simultaneous applications of other diagnostic surveillance techniques, with the same sensors and hardware, make possible complete monitoring of pressure vessels for the detection of incipient failures. 34 references. (auth)

9174 NUCLEAR REACTOR DIRECT PRESSURE SUPPRESSION CONTAINMENT. Chave, Charles T. (to Stone and Webster Engineering Corp.). U. S. Patent 3,414,472. Dec. 3, 1968. Filed July 12, 1966.

Direct pressure suppression in a nuclear reactor containment structure is achieved by providing a liquid reservoir of predetermined volume and specific gravity established at a point which is less than that of water so that steam condensing at the surface will sink into the reservoir. The sinking condensate causes circulation within the reservoir, enabling the reservoir to continually absorb steam until thermal equilibrium is reached. The liquid reservoir is preferably comprised of water diluted with either a fluid or particulate solid material so as to be in the form of either a solution, emulsion or solid-water suspension. Also preferably, the fluid additive material is selected so as to have a low vapor pressure to minimize the amount of vaporization generated upon steam condensation. (Offic. Gaz.)

9175 NUCLEAR REACTOR CONTROL USING NEUTRON ABSORPTION FLUID. Dastur, A. R. (to Canadian General Electric Co., Ltd.). Canadian Patent 794,050. Sept. 3, 1968.

The physical characteristics of gaseous boron hydrides B_2H_4 and B_2H_6 facilitate the rapid addition and removal from the annulus between the pressure and calandria tubes as a control device. Even more favorable neutron absorption is attained if these hydrides contain more than the natural proportion of ^{10}B. Control valves and arrangements are described for either shutdown or shim control. Kr, ^3He, and ^{135}Xe are also mentioned as alternate gaseous neutron absorbers. (F.S.A.)

9176 LIQUID POISON SAFETY SYSTEM FOR A NUCLEAR REACTOR. de Paratesi, Sergio Galli; Genet, Francois; Ghiurghi, Luciano; Agazzi, Alberto; Morbello, Mario; Broggi, Armando (to EURATOM). U. S. Patent 3,414,476. Dec. 3, 1968. Priority date Mar. 22, 1965, Belgium.

A system for selectively introducing a poison solution to stop the reactor or a washing solution to clean the system is described. The system includes a plurality of vertical rods in the reactor connected to top and bottom headers located on the respective ends of the reactor. An accumulator is connected to both of the headers and to valve means which selectively introduces the poison solution or washing solution. (Offic. Gaz.)

Operation and Economics

Refer also to abstracts 8169 and 8262.

9177 (HPR-103) HBWR QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1968. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1968. 148p. Dep.

HALDEN BOILING REACTOR—operations during July to September 1968
—fuel element failures in, effects on operations of
—control system for, description of fuel monitoring digital computer
NEUTRONS—effects on failures in Zircaloy-clad uranium oxide (UO_2) pellet-type fuel elements, analysis of
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fuel element test assembly of vibrocompacted, description of Halden Boiling Reactor
REACTOR CONTROL SYSTEMS—computer for Halden Boiling, description of digital
REACTOR FUEL ELEMENTS—failure of Halden Boiling Reactor, effects on operations of
—assemblies of, Halden Boiling Reactor Zircaloy 2- and Zircaloy 4-clad uranium oxide (UO_2) pellet-type, description of test
—assemblies of Halden Boiling Reactor (vibrocompacted plutonium oxide (PuO_2)–uranium oxide (UO_2), description of test
—assemblies of Halden Boiling Reactor Zircaloy 2-clad thorium oxide (ThO_2)–uranium oxide (UO_2), description of test
—radiation effects on failure of Zircaloy-clad uranium oxide (UO_2) pellet-type, analysis of neutron
THORIUM OXIDES ThO_2—ThO_2–UO_2, fuel element test assembly of, description of Halden Boiling Reactor
URANIUM OXIDES UO_2—fuel element test assembly of Zircaloy-2- and Zircaloy-4-clad pellet-type, description of Halden Boiling Reactor
—PuO_2–UO_2, fuel element test assembly of vibrocompacted, description of Halden Boiling Reactor
—ThO_2–UO_2, fuel element test assembly of, description of Halden Boiling Reactor
—radiation effects on failure of Zircaloy-clad pellet-type, analysis of neutron
ZIRCALOY-2—cladding for uranium oxide (UO_2) and thorium oxide (ThO_2)–uranium oxide (UO_2) fuel element test assembly for Halden Boiling Reactor
ZIRCALOY-4—cladding for uranium oxide (UO_2) pellet-type fuel element test assembly for Halden Boiling Reactor

9178 (K-D-2122) CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT. Senatore, Samuel J. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Sieder, Everett N. (Office of Saline Water, Washington, D. C.). Oct. 22, 1968. Contract W-7405-eng-26. 12p. (SM-113/33; CONF-681108-1). Dep. CFSTI.

From Symposium on Nuclear Desalination, Madrid, Spain.

The dual-purpose multistage flash plant and the water-only vapor-compression plant conceptual designs are described. The design and economics of the vapor-compressor cycle and of large vapor compressors are discussed. Capital costs and water costs are tabulated for the two plant concepts. (H.D.R.)

9179 (NP-17696) OECD HIGH-TEMPERATURE REACTOR PROJECT DRAGON. Ninth Annual Report, 1967-1968. (Organization for Economic Co-operation and Development, Paris (France)). 222p. Dep.

CESIUM ISOTOPES Cs-137—fission product release of, effects of burnup and temperature on coated tri-layer laminated carbon-silicon carbide-pyrolytic carbon particle-type uranium oxide (UO_2) fuel elements
GRAPHITE—radiation effects on mechanical properties of Gilsocarbon, analysis of neutron
HEAT TRANSFER SYSTEMS—mockup of High-Temperature Gas-Cooled Reactor Experiment, effects of water leakage into primary helium circuit on
HIGH-TEMPERATURE GAS-COOLED REACTOR EXPERIMENT—maintenance during April 1967 to March 1968
—operation during April 1967 to March 1968
—personnel for, listing of April 1967 to March 1968
—power history during April 1967 to March 1968
NEUTRONS—effects on laminar coated tri-layer pyrolytic carbon-silicon carbide-pyrolytic carbon particle-type uranium oxide (UO_2) fuel elements
REACTOR FUEL ELEMENTS—High-Temperature Gas-Cooled Reactor Experiment bonded-bed coated particle-type, development of
REACTOR FUELS—coating of particle-type, fabrication and testing of pyrolytic carbon-silicon carbide-pyrolytic carbon tri-layer laminated
REACTORS, HETEROGENEOUS—fuel cycle for high-temperature, analysis of optimum economic
REACTORS, POWER—fuel cycle for heterogeneous high-temperature, analysis of optimum economic
REMOTE-HANDLING EQUIPMENT—High-Temperature Gas-Cooled Reactor Experiment primary heat exchanger maintenance, development of
SEALS AND GLANDS—leak testing of High-Temperature Gas-Cooled Reactor Experiment cooling system silver-plated and indium-plated Inconel, analysis of
URANIUM OXIDES UO_2—fuel fabrication of particle-type, pyrolytic carbon-silicon carbide-pyrolytic carbon tin-layer, laminated coating for
—radiation effects on coated tri-layer laminated pyrolytic carbon-silicon carbide-pyrolytic carbon particle-type, analysis of neutron
XENON ISOTOPES Xe-133—fission product release of, effects of burnup and temperature on coated tri-layer laminated pyrolytic carbon-silicon carbide-pyrolytic carbon particle-type uranium oxide (UO_2) fuel elements (D.C.C.)

9180 (PEL-167) NUCLEAR POWER ECONOMICS. A Bibliography Covering 1965-1966. Rossouw, S. F. (comp.) (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jan. 1968. 82p. Dep.

Included are 242 references on power reactor economics covering national programs, power reactor types, fuel costs, uranium resources and requirements, and nuclear desalination. An author index is included. (H.D.R.)

9181 NUCLEAR POWER FOR LARGE INDUSTRY. Kaestle, F. L.; Marsh, W. D.; Bigge, W. B. (General Electric Co., Schenectady, N. Y. General Electric Co., San Jose, Calif.). Power Eng., 72: No. 12, 46-9(Dec. 1968).

The possibility of in-plant nuclear generation of electricity for a large power user is examined using the Al industry as an example. Economics of various combinations of unit sizes and number of spares is discussed for large Al reduction and fabrication plants. (H.D.R.)

Safety and Siting

9182 (BNWL-754) NUCLEAR SAFETY QUARTERLY REPORT, JULY-OCTOBER 1967 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT(45-1)-1830. 99p. Dep. CFSTI.

ACOUSTIC EMISSION METHOD—use for crack detection in reactor pressure pipe
CALCINATION—spray equipment and procedures for radioactive waste solutions, development of
CESIUM—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
CHROMIUM ISOTOPES Cr-51—concentration in Columbia River sedimentation, analysis of
COBALT ISOTOPES Co-60—concentration in Columbia River sedimentation, analysis of
COLUMBIA RIVER—sediments in, determination of γ-emitting
CONTAINMENT SYSTEMS EXPERIMENT—spray systems for, effectiveness for reduction of gas phase fission product concentration of
—coolant blowdown tests in, pressure transients during simulated pressurized-water reactor
DENSIMETERS—use for blowdown analysis of steam in simulated pressurized-water reactor pressure vessel
FISSION PRODUCTS—removal of gaseous, effectiveness of reactor containment spray systems for
—removal of aerosol methyl iodide, effectiveness of, hydrazine sprays for
HYDRAZINE—effectiveness of sprays of, use for removal of methyl iodide from reactor containment systems
IODINE—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
MANGANESE ISOTOPES Mn-54—concentration in Columbia River sedimentation, analysis of
METHANE, IODO—removal of fission product aerosols of, effectiveness of hydrazine sprays for
PIPES—crack detection in pressure, acoustic emission signal analysis for
PRESSURE VESSELS—pressure transients in, coolant loss accident simulation of 600°F and 2500 psi
RADIOACTIVE WASTES—disposal of gaseous, analysis of underground gas-injection methods for
—solidification of solutions of, spray calcination equipment and procedures development for
REACTOR CONTAINMENT SYSTEMS—fission product removal from, effectiveness of spray systems for gaseous
REACTOR SAFETY—coolant blowdown in simulated pressurized-water reactor, pressure vessel pressure transients for 600°F and 2500 psi
REACTORS, PRESSURIZED-WATER—pressure vessel for simulated, pressure transient for coolant loss accident at 600°F and 2500 psi in
—coolant blowdown in, pressure transients during simulated
SCANDIUM ISOTOPES Sc-46—concentration in Columbia River sedimentation, analysis of
TRANSDUCERS—development of acoustic emission analysis high-temperature capacitive
URANIUM—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
ZINC ISOTOPES Zn-65—concentration in Columbia River sedimentation, analysis of (D.C.C.)

9183 (BNWL-816) NUCLEAR SAFETY QUARTERLY REPORT, NOVEMBER 1967-JANUARY 1968 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT-(45-1)-1830. 152p. Dep. CFSTI.

ACOUSTIC EMISSION METHOD—use for crack detection in reactor pressure piping
ANEMOMETERS—calibration of heated thermopile, in steam-air atmospheres for fission product aerosol transport tests in CSE
BORIC ACID—effectiveness of reactor containment spray solutions containing, for gaseous fission product removal
CALCINATION—spray equipment and procedures development for radioactive waste solutions
CESIUM—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
CONTAINMENT SYSTEMS EXPERIMENT—coolant blowdown tests in, mass velocity during simulated pressurized-water reactor
—sampling systems for, performance of aerosol and liquid
—spray systems effectiveness in reduction of gas phase fission product concentration in
FISSION PRODUCTS—absorption of aerosols by stagnant reactive liquid drops, mathematical model for
—mass transport in reactor containment vessels, model for prediction of natural
—removal of gaseous, effectiveness of reactor containment spray systems for
—removal of methyl iodide aerosols by hydrazine sprays, washout rates for
GLASS—production of phosphate, for fixation of radioactive wastes

HYDRAZINE—effectiveness of sprays of, for methyl iodide removal from reactor containment systems
IODINE—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
METHANE, IODO—removal of fission product aerosols of, effectiveness of reactor containment spray systems for
—removal of fission product aerosols of, washout rates using hydrazine sprays for
PIPES—crack detection in pressure, by acoustic emission signal analysis
RADIOACTIVE WASTES—fixation by conversion to phosphate glass, evaluation of test runs for
—leach rates from phosphate glass in water
—solidification of solutions of, spray calcination equipment and procedures development for
REACTOR CONTAINMENT SYSTEMS—fission product mass transport in, model for prediction of natural
—fission product removal from, effectiveness of spray systems for gaseous
—methyl iodide removal from, effectiveness of hydrazine sprays for
REACTOR SAFETY—coolant blowdown in pressurized-water reactors, Containment Systems Experiment simulation of
—fission product aerosol removal from containment systems, effectiveness of spray systems for
REACTORS, PRESSURIZED-WATER—coolant blowdown in, mass velocity during simulated
STEEL—microstructure of 4-inch thick quenched and tempered A302-B, pressure vessel plate, correlation of fracture toughness with
TRANSDUCERS—development of high temperature capacitive, for acoustic emission analysis
URANIUM—removal of fission product aerosols of, effectiveness of reactor containment spray systems for (H.D.R.)

9184 (GAMD-7629) FRELIM CODE FOR ESTIMATING RELEASE OF LESS VOLATILE METALLIC FISSION PRODUCT ELEMENTS. Zumwalt, L. R.; Pierce, V. H. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 11, 1967. Contract AT(04-3)-633. 6p. Dep. CFSTI.

The FRELIM code for estimating the release of fission products from an assembly of HTGR fuel elements (i.e., reactor core) gives the limit for the release of any isotope of a given fission product element by evaporation in the coolant stream. The code is particularly useful for the estimation of the maximum possible release of the less volatile metallic fission product elements (i.e., Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, In, Sn, Sb, La, Ce, Pr, Nd). The estimated release is, in general, expected to be an upper limit since the process of diffusion of isotopes of elements of low volatility through graphite of the fuel element to the graphite-coolant interface will tend to be the mass transport process that actually limits release. (auth)

9185 BURST CAN DETECTION SYSTEM FOR NUCLEAR REACTOR. Guyonvarh, Michel; Le Meur, Roger; Roguin, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,413,469. Nov. 26, 1968. Priority date May 13, 1964, France.

Fuel element can failures in a gas cooled nuclear reactor are located by a number of detection units each having a delayed neutron detector and an electrostatic collection detector. The fuel channels of the reactor are grouped into assemblies and into subassemblies and through a valve system to a scanning circuit having a detection unit. Each assembly can be connected to a burst can follower circuit having a detection unit for electrostatic collection of solid fission products. (Offic. Gaz.)

9186 NUCLEAR SAFETY. Volume 10, No. 1. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Jan.-Feb. 1969. 120p. GPO $0.60.

Research and development efforts in the field of nuclear safety are summarized. Abstracts are prepared for the sections on the ten major areas of interest. (M.L.S.)

For abstracts of individual sections see: 9109, 9110, 9129, 9132, 9173, 9187–9190, and 9217.

9187 FAST REACTOR SAFETY. Wolfe, B. (General Electric Co., San Jose, Calif.). Nucl. Safety, 10: 19-27(Jan.-Feb. 1969).

Safety plays a major role in considerations of fast reactor design and development. Work to date indicates that, with respect to reliability and provisions for foreseeable malfunctions of equipment, fast reactors should be able to meet and possibly exceed the high standards set by the more mature water-cooled reactor systems. It is in the area of very-low-probability, end-of-spectrum, hypothetical accidents that technical questions regarding fast reactors are encountered which differ from those related to other reactor systems. An overall perspective view of fast reactor safety is presented, and, within this context, some technical questions involved in hypothetical accident analysis are discussed. 20 references. (auth)

9188 COMMON MODE FAILURE CONSIDERATIONS IN THE DESIGN OF SYSTEMS FOR PROTECTION AND CONTROL. Epler, E. P. Nucl. Safety, 10: 38-45(Jan.-Feb. 1969).

A failure of instrumentation in the control system can initiate the need for reactor protection. If the same circumstances also can induce failure of the instrumentation that was provided to protect against the control failure, a potentially hazardous situation exists. Similar, or particularly identical, instruments are susceptible to such common mode failures. Examination of simultaneous failure incidents in reactor protection systems indicates that the use of identical channels of instruments is only marginally acceptable for protection alone. Identical channels in both the protection and control systems are unacceptable if protection against failures of the control channels is provided solely by the identical channels in the protection system. (auth)

9189 AIR CLEANING AS AN ENGINEERED SAFETY FEATURE IN LIGHT-WATER-COOLED POWER REACTORS. Keilholtz, G. W.; Battle, G. C. Jr. Nucl. Safety, 10: 46-53(Jan.-Feb. 1969).

Air-cleaning systems provided to minimize the release of radioactive fission products to the environment after postulated major accidents in light-water-cooled power reactors must be able to withstand the accidents and to perform reliably and effectively under postaccident conditions. Spray cooling systems and pressure-suppression pools adapted for iodine removal by a chemical additive are being investigated for application to post-accident air cleanup within the containment system. Both should be reliable, but their efficiencies for air cleaning have not yet been fully evaluated. Recirculating filter–adsorber systems are suitable as engineered safety features primarily for containment-atmosphere cleanup after minor accidents because of the cost of ensuring their adequacy is high. Once-through filter–absorber systems that clean and exhaust the air from secondary containment buildings or volumes are highly recommended as engineered safety features, provided that their effective and reliable post-accident performance is assured by proper design, construction, testing, inspection, and maintenance. 27 references. (auth)

9190 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. (eds.). Nucl. Safety, 10: 85-105(Jan.-Feb. 1969).

Summaries of the following nuclear safety research and development projects are given: Water Reactor Safety including reactor kinetics and related studies, integrity of primary systems, loss of coolant and containment response, fission product behavior under accident conditions, multipurpose projects (LOFT, CSE, analytical description of a reactor accident), in-plant testing, and criteria, codes, standards, and specifications. 59 references. (M.L.S.)

Power Conversion Systems

9191 IMPROVEMENTS IN OR RELATING TO STEAM POWER PLANTS. (to Babcock and Wilcox Ltd.). British Patent 1,137,452. Dec. 18, 1968. Priority date June 7, 1966, France.

HEAT TRANSFER SYSTEMS—flow diagram for pressurized-water power reactor
REACTORS, POWER—power conversion system of pressurized-water, flow diagram for
REACTORS, PRESSURIZED-WATER—power conversion system of power, flow diagram for (D.C.C.)

9192 STIRLING CYCLE WITH NUCLEAR FUEL. Kolin, Ivo (Zagreb Univ.). Nucl. Eng. Int., 13: 1028-34(Dec. 1968).

Various possible ideal thermodynamic cycles are considered, and the applicability of the Stirling cycle to use with a nuclear reactor is discussed on the basis of the Schmidt theory. It is concluded that the advantages of the use of the Stirling cycle in a nuclear power station include higher efficiency than steam or gas turbine cycles, higher temperature difference, simple power regulation, high specific power output, lack of requirement for boiler or heat exchanger and auxiliaries, and an over-all simplicity of construction. (UK)

Research and Test Reactors

Refer also to abstracts 8129, 8247, 8265, 8274, 8305, 8339, 8916, and 9237.

9193 (BNWL–755) INSULATION OF THE FFTF CLOSED LOOP TUBES. Sawtelle, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

The FFTF closed loop tubes will operate in liquid Na at a temperature level of up to 1400°F with a wall temperature difference of 400°F. Methods of providing insulation to reduce heat transfer and thermal stresses to acceptable levels are evaluated. A twin-wall tube was chosen to provide an annular gap, isolated from the sodium, for the insulating materials, and to provide a gas circulation channel for controlling the thermal conductivity of the tube wall. (auth)

9194 (CEA-R–3477) PEGASE: SAFETY STUDIES; EXPERIMENTAL STUDY OF BURN-OUT RISKS IN TRANSIENT OPERATION. Vernier, Philippe (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sept. 1968. 87p. (In French). Dep.

An experimental out-of-pile set-up is proposed simulating the breakage of a pipe supplying the core of the reactor PEGASE. The two fast phenomena, depressurization of the vessel and flow reversal are reproduced. The Al heating channel has the same shape as that of the reactor channel but has twice the heat capacity. The starting conditions are V = 4, 50 and 6 m/sec, T_E = 50 and 60°C and P_E = 4 bars. The results show that the critical flux ϕ_c varies with the flow-rate from 45 to 60 W/cm² in the case where there is no power reduction. For fluxes of 90 W/cm² the results lead to the conclusion that the hot channel attains a state of burnout after 0.1 sec and that its temperature reaches 500°C in 0.8 sec. The hydrodynamic conditions of the channels after the accident involve periodic expulsion (0.2 to 0.5 sec), characteristic of boiling at low pressure. A study of the steady state flow redistribution through a bypass has given flux redistributions ϕ_R of 190 W/cm² for a flow rate of 4.5 m/sec at 50°C, and 175 W/cm² at 60°C. These values increase by 25 percent for a flow-rate of 6 m/sec. The distinction which is made between the critical flux ϕ_c during the periodic expulsion conditions and the flux redistribution ϕ_R during the steady state, is shown. 5 references. (auth)

9195 (IDO–17274) FAULT TREE ANALYSIS OF THE PBF TRANSIENT ROD DRIVE SYSTEM. Headington, W. L.; Stewart, M. E.; Zane, J. O. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1968. 140p. Dep. CFSTI.

Results of a study using the fault tree analysis methods for critical assessment of the PBF transient rod system are presented. Included is a description of these methods exemplified by their application to the PBF system. The results of the study indicate this approach can be applied for the reliability evaluation of those engineered safety systems associated with reactor power plants. In particular, this approach provides a tool which could be used to demonstrate compliance with reliability standards for safety systems. (auth)

9196 (KFK–782) EXPERIMENTAL INVESTIGATION OF THE SAFETY SYSTEM OF THE FR2 (CORE WITH UO_2-FUEL ELEMENTS). Steiger, W.; Wildberg, D. (Kernforschungszentrum, Karlsruhe (West Germany)). June 1968. 26p. (In German). Dep.

The uranium oxide loaded core for the FR-2 is described; a cross section of the core is given. Neutron flux plots are shown as a function of time for both log and linear channels. Results of period channel measurements are shown graphically. Schematics of the safety circuit are given. Flux and period channel data are tabulated, also. (M.L.S.)

9197 (KFK–789) INVESTIGATION OF THE REACTION OF LIQUID HYDROGEN WITH LIQUID AIR IN A PRESSURE TUBE. Karb, Erich H. (Kernforschungszentrum, Karlsruhe (West Germany)). July 1968. 58p. (In German). Dep.

A pressure tube should protect the FR-2 reactor from the consequences of a hydrogen–air reaction, which is conceivable in the breakdown of several safety devices of the planned cold neutron source Project FR-2/16. The magnitudes and time pattern of the pressures to be expected were investigated. In the geometry used and the ignition mechanism selected, which is comparable with the strongest ignition process conceivable in the reactor, the reaction proceeds with greater probability than combustion. The combustion is possibly smaller if local limited partial detonations are superimposed. The magnitude of the pressure was determined by the masses of the reaction partners, liquid H_2 and liquid air, and determines their ratio to each other. In the liquid H_2 volume of 250 cm³ introduced into the cold neutron source and a liquid air constituent of 30 to 40% of the stoichiometric mass, the following pressures are to be expected: local pressure peaks of a maximum of 360 to 470 atm, which are built up in a time of 0.1 msec at the longest and then decline, and a total internal pressure of a maximum of 240 to 310 atm, which is built up in the course of 0.5 msec at the shortest and are maintained for one or several msec. In comparison to the short local pressure peaks these are seen as effectively static. (tr-auth)

9198 (KURRI-TR–28) HEAVY-WATER THERMAL-NEUTRON FACILITY AT KUR. Shibata, Toshikazu; Okamoto, Boku; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). Feb. 1968. 22p. (In Japanese). Dep.

A standard heavy-water thermal column, weighing about 2 tons, is installed in the Kyoto University Reactor. This column has many advantages in the experiments of reactor physics and engineering, and irradiation experiment of biological chemistry. Various data, required by its users, i.e., the intensities and distributions of thermal neutrons and gamma-rays, have been measured in the different conditions. The results of measurements, as well as the thermal column, etc., are described. It was shown that a maximum neutron flux of 6×10^{10} n/sec.cm² is available, and the separation of γ-rays and neutrons is fairly satisfactory. (NSA of Japan)

9199 (NP-tr–1712) EXPERIMENTAL STUDY OF THERMAL NEUTRON SPECTRA FROM COLD SOURCES OF LIQUID HYDROGEN AND DEUTERIUM. Ageron, P.; de Beaucourt, P.; Harig, H.; Lacaze, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report RHF–66-20. 31p. Dep. CFSTI.

In order to investigate cold neutron sources for a high flux reactor, various moderators of liquid deuterium and hydrogen were investigated. The results obtained are reported as spectra, as gain factors from the ratio of a cold spectrum to the spectrum leaving an unperturbed reflector, and as comparisons of different moderator chambers. The corrections made to the measured spectra are stated and the cryogenic design of the experiment and counting equipment are briefly described. (auth)

9200 (TID–24855) [FAST REACTOR FUELS AT THE KARLSRUHE FACILITY IN GERMANY]. Monthly Report No. 49. Macherey, Robert E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Nov. 1968. 10p. Dep. CFSTI.

Irradiation operations in the FR-2 reactor are described. Burnup performances of UO_2 and PuO_2–UO_2 fuel assemblies are discussed. The irradiation of PuO_2–UO_2 fuel assemblies in the BR-2 reactor is described. The performances of Mol 1, Mol 2, and Mol 3 specimens in the BR-2 reactor are also described. (D.C.C.)

9201 (TID–24857) REPORT NO. 14, AUGUST–OCTOBER 1968. Stachura, Stanley J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 31p. Dep. CFSTI.

Topics discussed include: safety studies with Cabri coolant-loss flow experiments, fission product transport, and Na fires; thermal and mechanical studies with loop descriptions and safety-related experiments; Rapsodie control rod experience; and evaluation of Pu alpha and comparison of B and Ta control materials. (D.C.C.)

9202 ON THE CONCEPTUAL DESIGN OF THE EXPERIMENTAL D_2O CRITICAL FACILITY (ATRC). Nakano, Hideo (Fuji Electric Mfg. Co., Ltd., Tokyo); Shiraha, Michihiro. FAPIG (Tokyo), No. 49, 28-37(June 1968). (In Japanese).

The main features of the D_2O moderated, light-water cooled ATRC with output 1 kW are as follows: core tank filled with D_2O and containing the upper and lower grids and calandria tubes; fuel assemblies with fuel clusters and pressure tubes; and reactivity control with control rods and lowering of the D_2O level. (NSA of Japan)

9203 SAMPLE IRRADIATION DEVICE. Nakai, Yasushi (to Mitsubishi Atomic Power Industrial, Inc.). Japanese Patent 1968-18517. Aug. 8, 1968. Filed Mar. 10, 1966.

The device proposed is for sending and withdrawing sample capsules to near the reactor core by means of a fluid. The advantages to the method are: irradiation of many capsules at the same time, and the taking out of any capsules irradiated. It consists of the following: the cylindrical capsule holder rotatable at the irradiation position with many capsule-containing holes running in parallel with the rotating axis; a number of blades fixed on the outside of the cylindrical holder; a capsule conveyer tube connected to the opening of the capsule-containing holes; a fluid-supply tube connected to the blades; a fluid-supply tube with one opening passing through the capsule conveyer tube and the capsule-containing holes and the other opening passing through the gap between the fluid supply tube and the blades; and, a limit switch for detecting the

position of joint of the capsule-containing holes and the conveyer tube. (NSA of Japan)

9204 SAMPLE IRRADIATION DEVICE. Nakai, Yasushi (to Mitsubishi Atomic Power Industrial, Inc.). Japanese Patent 1968-18516. Aug. 8, 1968. Filed Mar. 10, 1966.

The irradiation device consists of the following: a rotating capsule holder with a capsule-containing hole cut in the direction perpendicular to that of the rotation axis; a number of blades extending radially at the ends of the rotation axis; a capsule stopper located at the center of the containing hole where only a fluid can pass; a capsule conveyer tube running to the irradiation position which connects to the opening of the capsule containing hole; a fluid-path tube running along the same route as for the conveyer tube; a tube device for supplying a fluid to the blade so that the two can rotate in the opposite directions; a device for stopping the rotation of the capsule holder at the joint of the conveyer tube and the sample containing hole; and, a device for indicating the position of the capsule holder when the capsule-containing hole opening joins the conveyer tube. (NSA of Japan)

9205 MINIMUM ^{235}U CRITICAL MASS IN D_2O. Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 5: 294(Nov. 1968).

Critical mass data are presented for bare and reflected H_2O- and D_2O-moderated spheres. It is shown that, while the minimum critical mass in D_2O is a factor of 2 larger than in H_2O reflected by Be, the minimum ^{235}U concentration is decreased by an order of magnitude. (H.D.R.)

9206 REACTIVITY CONTRIBUTIONS IN THE GLORY HOLE OF THE SANDIA PULSED REACTOR II. Long, Robert L. (Univ. of New Mexico, Albuquerque). Nucl. Appl., 6: 8-15(Jan. 1969).

Measurements of the reactivity contributions of a number of materials have been made in the 1.5-in.-diameter glory hole of the Sandia Pulsed Reactor II (SPR II). In similar measurements at Los Alamos Scientific Laboratory in Godiva, materials with very low absorption cross sections had a positive reactivity effect at the core center, but at the center of the SPR II glory hole, the same materials produced negative reactivity effects. The differences are probably due to changes in the neutron energy spectrum and scattering contributions. Results of prompt burst operations with samples in the glory hole show that changes of several cents can readily occur in the reactivity worth of the burst rod. (auth)

9207 HIGH TEMPERATURE FURNACE IN A MATERIALS TESTING REACTOR. Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.); Mason, F.; Wait, E.; Wright, G. S. Nucl. Energy, 130-4(Sept.-Oct. 1968).

The development and operational experience of a high temperature furnace in a materials testing reactor is described. The furnace was proved over a prolonged period of time and was used for studies of fission product migration and radiation damage processes in ceramic fuel materials. (auth)

9208 CRITICAL EXPERIMENTS WITH HOMOGENEOUS PuO_2–POLYSTYRENE AT 5H/Pu. Bierman, S. R.; Hansen, L. E.; Lloyd, R. C.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Nucl. Appl., 6: 23-6(Jan. 1969).

The results and analyses are presented from the latest series of experiments in a continuing program for determining the critical parameters of Pu mixtures having concentrations that are typical of wet powders, precipitates, slurries, and polymers. The initial series of measurements in this program were made on 15H/Pu fuel having ^{240}Pu isotopic concentrations of 2.2 and 8.08 wt %. The latest experiments were conducted with fuel having a ^{240}Pu isotopic concentration of 11.46 wt % and a H/Pu atomic ratio of 5. Generally, these results indicate that the published values for the critical sizes and masses of Pu should be increased for the highly concentrated systems. Additional data are needed, however, to better establish the criticality curves in this region. The 11.46 wt % ^{240}Pu isotopic concentration caused an increase of ~30% in the spherical critical mass of a bare ^{239}Pu-water system at 5H/Pu. In the reflected system the increase was ~43%. (auth)

9209 USE IN PHYSICS AND MEDICINE OF THE SIEMENS TRAINING REACTOR SUR 100. Knapp, J.; Keinert, J.; Hehn, G.; Speidel, V.; Szirmai, E. (Univ., Stuttgart). Nucl. Energy, 146-50(Sept.-Oct. 1968).

A brief description is given of the design and operation of the 0.1 W reactor. Its use for teaching and training in the field of nuclear engineering, and as a neutron source for studies in physics, nuclear medicine, biology, and chemistry is summarized. (UK)

9210 FAST PULSED REACTOR "VIPER." PART 1. GENERAL DESCRIPTION. Weale, J. W.; Goodfellow, H.; McTaggart, M. H.; Warnke, E. G. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Brit. Nucl. Energy Soc., 7: 313-27(Oct. 1968).

The reactor operates on a single-shot basis at a frequency of not more than two pulses per day. The pulses are 400 μs wide, with a peak power of 20,000 MW. The general principles of the design of fast pulsed reactors are briefly reviewed, and the application of these principles in the design of the VIPER reactor is described. Emphasis is placed on the novel features, which include the use of the Doppler coefficient to terminate the prompt critical pulse. (UK)

9211 FAST PULSED REACTOR "VIPER." PART 2. REACTOR PHYSICS MEASUREMENTS AND ANALYSIS. McTaggart, M. H.; Goodfellow, H.; McCormick, W. B.; Weale, J. W. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Brit. Nucl. Energy Soc., 7: 328-42(Oct. 1968).

A series of experiments and calculations is described by which the physics characteristics of the reactor, and the fission yields and radiation doses in a full size pulse were determined. (UK)

9212 GAMMA AND NEUTRON DISTRIBUTION IN A TUNGSTEN WATER-MODERATED CRITICAL ASSEMBLY. Houghton, George (United Nuclear Corp., Elmsford, N. Y.); Jupiter, Clyde; Trimble, Gerald; Spielberg, David; Klann, Paul G.; Paulson, Walter A. Nucl. Appl., 6: 81-(Jan. 1969).

The absolute γ dose was measured at 60 locations within the Tungsten Water-Moderated Reactor critical assembly. The neutron dose was measured at 30 locations. Graphite wall thimble ionization chambers filled with CO_2 were used for γ measurements and polyethylene wall chambers filled with ethylene were used for mixed γ and neutron fluxes. The chambers were absolutely calibrated in a bremsstrahlung beam against a secondary calibration standard and in a reactor against a water filled calorimeter. These calibrations were used to determine the absolute γ and neutron responses for the chambers. This permitted partitioning the measured mixed radiation dose into a γ dose and a neutron dose. The measured γ doses were compared with an ATHENA Monte Carlo calculation. Good agreement was found for the 16 locations compared. The average deviation was 10%. In addition, the measured neutron doses were compared with a "first collision" calculation of the dose. The calculated neutron doses were uniformly low with with an average deviation from the measurement of 18%. (auth)

9213 CONTROL ROD SYSTEM FOR NUCLEAR POWER EXCURSION REACTORS. de Paratesi, Sergio Galli; Rinaldini, Carlo (to EURATOM). U. S. Patent 3,406,093. Oct. 15, 1968. Filed Apr. 12, 1966.

A control system for affecting bi-directional, variable speed movement of control rods in the core of a nuclear reactor, especially adapted for use in reactors of the power excursion type, is described. (Offic. Gaz.)

9214 RULE OF THUMB FOR FAST FLUX IRRADIATIONS. Kelber, Charles N. (Argonne National Lab., Ill.). Nucl. Appl., 6: 6-7(Jan. 1969).

Simple rules for estimating the magnitudes of power densities in the irradiation volume and the accompanying flux converter and filter assembly of thermal test reactors are presented. The estimates obtained from the application of the rules are used to evaluate candidates for irradiation testing. (D.C.C.)

9215 COMPUTER CONTROL ALGORITHM FOR A NUCLEAR REACTOR SUPPORT SYSTEM. Kosorok, John Roger. Corvallis, Oreg., Orgeon State Univ., 1968. 192p.

Thesis.

The High Temperature Lattice Test Reactor (HTLTR) operates at temperatures up to 1000°C. Its low nuclear power requires a 384 kilowatt electrical heating system that is divided into four circuits to attain the high temperatures in the ten-foot cube of moderating graphite. The design and evaluation of an algorithm for digital computer control of the heating system is described. (Disser. Abstr.)

9216 MEASUREMENT OF MARCROSCOPIC PARAMETERS OF URANIUM–LIGHT WATER LATTICES. APPLICATION TO NONUNIFORM LATTICES. Gavin, Paul (Univ., Lausanne, Switzerland). Z. Angew. Math. Phys., 19: 718-29(Sept. 25, 1968). (In French).

Time dependent and independent measurements on a subcritical multiplying medium lead to the determination of the two group diffusion constants: k, L_1^2, L_2^2, l_{01} and l_{02}. The measured values are related to these constants through five independent expressions. Similar measurements have been made on non-uniform cylindrical lattices in which the pitch is a function of the radius. In such lattices, the radial fluxes are expressed by Bessel function series used to define a generalized expression for the effective multiplication factor. (D.C.C.)

9217 CONTROL-ROD MATERIAL PROBLEMS OF RESEARCH REACTORS. Martin, R. D. (Univ. of Michigan, Ann Arbor). Nucl. Safety, 10: 63-72(Jan.-Feb. 1969).

Control-rod material problems in research reactors have not caused any serious reactor accidents. However, repetition of poor designs (B_4-powder-filled pool-reactor control rods) and insufficient mechanical testing of full-sized control rods have resulted in some problems that could have been avoided. The power-reactor operating experience with cracked boron–stainless steel control rods may be pertinent to research reactors operating in the megawatt regions. As research reactor operating experience with various control-rod materials increases, an improved means of regularly disseminating operational-problem information is needed. 38 references. (auth)

9218 REACTIVITY MEASUREMENTS AND NUCLEAR POWER CALIBRATION OF THE 5 x 5 CORE CONFIGURATION OF THE FMRB. Knauf, K.; Roethemeyer, H. PTB Mitt., 78: 362-8(Oct. 1968). (In German).

The commissioning program of the Measuring and Research Reactor (FMRB) involves the initial tests of the whole facility with a 5 × 5 core configuration. A description is given of the critical experiment, reactivity measurements and nuclear power calibration for this core. Reactivity measurements have been performed by asymptotic period and rod drop techniques. Reactor power was determined by means of measuring the thermal neutron flux distribution of the core by activation of Dy-wires. (auth)

9219 A PLATE-TYPE NUCLEAR FUEL ELEMENT. Lorin, Christian (to Commissariat a l'Energie Atomique). British Patent 1,137,597. Dec. 27, 1968. Priority date July 26, 1966, France.

REACTOR FUEL ELEMENTS—description of swimming-pool reactor pivoting-hinge-supported multiple parallel sheathed plate-type, for swimming pool reactors

REACTORS, SWIMMING-POOL—fuel elements for, description of pivoting-hinge-supported multiple parallel sheathed plate-type (D.C.C.)

Rocket and Space Reactors

Refer also to abstracts 8170, 8246, and 8491.

9220 EFFECT OF THERMIONIC POWER SYSTEM PERFORMANCE ON THE MISSION CAPABILITY OF NUCLEAR ELECTRIC SPACE VEHICLES. Coggi, John V. (Douglas Aircraft Co., Santa Monica, Calif.). pp 174-82 of Aviation and Space: Progress and Prospects. New York, American Society of Mechanical Engineers, 1968.

From Annual Aviation and Space Conference, Beverly Hills, Calif. See CONF-680639.

The results of a study for the possible application of a thermionic reactor power system for electric propulsion space vehicles are presented. To perform unmanned missions to the outer planets a reactor power level of 1 MW(e) and a design life of 15,000 hours is desirable. Multiple reactors of the same power rating can then be used for manned missions. A realistic estimate of the electric-power system specific weight is made by utilizing components either presently under development with verified performance and reliability data, or using component designs which represent reasonable performance goals within today's technology standards. The payload capacity of the electric propulsion vehicle was compared with advanced chemical boosters and the nuclear stage. The electric propulsion unit shows an increasing payload advantage as the mission velocity increment becomes more difficult. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 9178.

9221 (ORNL-TM-2188) DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR. Ball, S. J.; Clapp, N. E. Jr.; Squires, B.; Van Winkle, R. (Oak Ridge National Lab., Tenn.). July 8, 1968. Contract W-7405-eng-26. 89p. Dep. CFSTI.

Dynamics experiments were performed on the three-stage AMF flash evaporator at Millstone Point, Conn., in June 1967 to verify theoretical calculations of large MSF plant dynamic behavior. Frequency response tests were run at operating temperatures between 100 and 140°F, tray-brine flowrates between 0.4 and 0.7 × 10^6 lb/hr per foot of width, and with both plain and baffled interstage orifice designs. Pseudorandom binary sequences were used as input perturbation signals for the recirculating brine and brine heater steam flow control valves. The measured results indicate that the fixed-coefficient, single-phase flow orifice equation is inadequate for describing transient interstage orifice flowrates. Improved models were derived for the tray brine vaporization rate and flow dynamics. The scope of the experiments was reduced due to equipment difficulties and to excessively large inherent temperature fluctuations under certain operating conditions. 21 references. (auth)

Marine and Portable Power Reactors

9222 (JAERI-1166) CRITICAL EXPERIMENT AND ANALYSIS ON THE CORE FOR JAPAN FIRST NUCLEAR SHIP REACTOR. Matsuura, Shojiro; Kobayashi, Iwao; Tsuruta, Harumichi; (and others) (Japan Atomic Energy Research Inst., Tokyo). Sept. 1968. 120p. Dep.

A series of zero power critical experiments has been carried out to confirm the nuclear characteristics of the reactor, preliminarily designed for the Japan first nuclear ship, as well as to examine experimentally the design model for the two region core of the light water moderated power reactor. The experimental and analytical procedures and results on reactivity of the core, burnable poison worth, control rods worth, power distributions, neutron flux distributions and reactivity coefficients are presented. The complete results and over-all conclusions based on the various experimental and analytical efforts are included. (auth)

9223 SUMMARY OF THE BASIC DESIGN ON THE FIRST NUCLEAR SHIP. Nagamoto, Yoshio (Japan Nuclear Ship Development Agency, Tokyo). Genshiryoku Chosa Jiho, No. 16, 28-47(June 1968). (In Japanese).

Classification of the first nuclear ship is NS*, MNS* of Nippon Kaiji Kyokai, and the construction is in accordance with both domestic and international treaties, laws, and standards. Its construction and machinery must have the strength, operation, performance, and load characteristics to be safely operated under the hull conditions normally encountered on the sea. The main parameters of the first nuclear ship are as follows: length × breadth × depth/loaded draft, 116 × 19 × 132/6.9m; loaded displacement, 10,400 KT; gross tonnage, 8350T, 3 holds; men on board, 79; main turbine, cross-compound type; saturated steam turbine with double reduction gears; output max continuous, 10,000SHP; normal 9000SHP; speed 16.5 Kn; type of reactor, light-water cooled, light-water moderated, pressurized water type, 1 set; thermal power, 36MW; and pressure and temperature in the primary system, 110 Kg/cm^{2}g, 278°C. (NSA of Japan)

Production Reactors

9224 (CEA-R-3556) DETECTION OF RADIOACTIVE GASES IN THE CO_2 COOLANT OF THE G2-G3 REACTORS. Pouthier, Jacques; Rossi, Jacky (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Sept. 1968. 29p. (In French). Dep.

The CO_2 cooling the reactors G2–G3 contains activation gases and fission gases. Gas-phase chromatography is applied daily for carrying out analyses. The chromatogram has separate peaks due to T, ^{41}Ar, ^{85}Kr, ^{133}Xe, and ^{135}Xe. By integrating each peak it is possible to calculate the specific activity of each product. The construction of an apparatus for carrying out continuous measurements is under consideration. (auth)

Reactor Theory

9225 (BMwF-FBK-68-32) ANALYTICAL METHOD TO CALCULATE THE SPACE DEPENDENT NEUTRON SPECTRUM IN A HETEROGENEOUS REACTOR CELL WITH ANY GIVEN MODERATOR. Kammerer, P. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Struktur der Materie). July 1968. 55p. (In German). Dep.

Using diffusion theory with energy dependent diffusion coefficient and the generalized heavy gas model, an analytical solution is given for the space and energy dependent neutron flux. It is assumed, that the absorption follows the 1/v-law, or can be expanded in powers of 1/v. Spectra are calculated for cells of different moderators (H_2O, graphite, D_2O). They are compared with numerical results and calculations using the simple heavy gas model. It is seen that using the improved generalized heavy gas

model instead of the simple heavy gas model gives a difference up to 20% even in the center of the fuel rod. 29 references. (auth)

9226 (BNL-13053) LOCATION OF HIGHER SPATIAL HARMONIC STABILITY CRITERIA. Lellouche, G. S. (Brookhaven National Lab., Upton, N. Y.). Oct. 28, 1968. 35p. Dep. CFSTI.

Reactor linear stability criteria are developed in both one and two group representations. Prompt xenon yield is neglected; the flux distribution is assumed to be in a quasi-static distribution. The equations are developed for the bare reactor; then reflector effects are considered. (M.L.S.)

9227 (CEA-R-3549) MULTIGROUP CALCULATION OF THE FAST FISSION FACTOR IN A THERMAL REACTOR LATTICE. Stefanovic, Dusan B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 56p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

To improve the fast fission factor calculation in graphite and heavy water lattices, a multigroup method with a matricial formulation was chosen. Assumptions can thus be avoided. Back-scattering and interaction effects were calculated by combining Monte-Carlo and multigroup methods. From a set of Monte-Carlo calculated probabilities, the multigroup spectrum of neutrons entering a rod were defined from the spectrum of the neutrons leaving the rod. A new definition of the fission factor, which takes into account back-scattering and interaction in a reactor lattice, was obtained. Results are compared to recent experimental data. (auth)

9228 (DRP/SETR-66/208) CALCULATIONS OF VARIATIONS OF THE LIFETIME OF NEUTRONS, OF THE REACTIVITY PRODUCED BY THE INTRODUCTION OF A SAMPLE, AND OF THE EFFECTIVE FRACTION OF DELAYED NEUTRONS BY MEANS OF PERTURBATION THEORY. Usachev, L. N.; Zaritskii, S. M. Translated into French from Byull. Inform. Tsentra Yadern. Dannym, No. 2, 242-6(1965). 7p. (In French). Dep.

Perturbation theory is used to derive formulas expressing the lifetime of neutrons, the reactivity produced by the introduction of a sample, and the effective fraction of delayed neutrons. (J.S.R.)

9229 (EURFNR-540) STRUCTURAL, EXPANSION, AND BENDING EFFECTS IN THE FAST REACTOR. PART I. THEORY. Hoang, Y. S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-539/I. 43p. (EUR-3951(Pt.1)). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

During power operation of a reactor, a space-dependent power distribution field and a space-dependent temperature field develop. Power changes alter coolant and structure temperatures and deform the reactor. Previous theoretical studies on the reactivity effects of the bending of fuel elements from their fixing and support conditions are extended to the special conditions of a 1000 MW(e) fast breeder. A digital code is used for parameter studies which identify the optimum location of support disks for the fuel element subassembly boxes. The bending reactivity coefficients are determined for all possible steady-state power conditions in the reactor. (H.D.R.)

9230 (UJV-1999) DEPENDENCE OF PARAMETER a IN RATIONAL APPROXIMATION OF THE FUEL ESCAPE PROBABILITY ON TEMPERATURE AND INTERFERENCE SCATTERING (IN RESOLVED RESONANCES REGION). Stepanek, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1967]. 23p. Dep.

Methods of determining resonance parameters for the fuel region of a reactor core are described. Data are tabulated for ^{238}U-metal and $^{238}UO_2$ systems. A solution for the resonance integral for heterogeneous system is obtained. 14 references. (M.L.S.)

9231 (WAPD-TM-749) DEVELOPING FLEXIBILITY MATRICES USING CTAC RULE. Bitner, J. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1968. Contract AT(11-1)-Gen-14. 32p. Dep. CFSTI.

Four examples illustrating a technique for evaluating elemental flexibility matrices, connection matrices, and total flexibility matrices are presented. A systematic matrix manipulation procedure called the CTAC rule is used to calculate the total flexibility matrix from the elemental flexibility and connection matrices. References to digital computer shock programs are made when applicable. (auth)

9232 CALCULATIONS OF NEUTRON DISTRIBUTIONS BY STATISTICAL METHOD. Yamagishi, Tomejiro; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 614-23(Dec. 1968).

Considering the displacement in the generalized random walk process of isotropic scattering neutrons as random variable the probability density function is obtained through the use of the statistical characteristic function. The total neutron distribution is expressed as a Fourier transform of the power series of this characteristic function. Using this statistical method, the total distributions are shown by means of concrete examples to agree with the solutions of the relevant linear Boltzmann equations which are already solved. The one dimensional space-angle dependent case is examined for a system containing random empty gaps. 14 references. (auth)

9233 BASIC STUDIES ON THE ROSSI-ALPHA EXPERIMENT. THE CORRELATION AMPLITUDE. Iijima, Tsutomu (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 624-34(Dec. 1968).

The results are given of theoretical and experimental studies on the correlation amplitude in the Rossi-α experiment, which does not follow Orndoff's theory in the usual procedure of measurement. It is shown that the correlation amplitude depends on the condition of the trigger count, and that Orndoff's amplitude is the average of those triggered by all pulses from the detector. Experimental results substantiating this theory are presented. The two-fork approximation is proved from experiment to be a good approximation near the critical state, which is a revelation of practical significance. A new method is proposed for obtaining the correlation amplitude by measuring the distribution of the number of family counts, and its application promises to be of great practical usefulness. (auth)

9234 CALCULATION OF THE FACTORS OF RESONANCE SELF-SHIELDING. Knapp, J.; Siegert, H. J. (Univ., Stuttgart). Atomkernenergie, 14: 30-4(Jan.-Feb. 1969). (In German).

A method for an exact calculation of the factors of resonance self-shielding f_γ under consideration of Doppler effect in homogeneous infinite media is described. Various approximations for a more simple calculation are given. For ^{238}U the f_γ-factors for the energy groups between 4.65 eV and 2150 eV for various temperatures and various relations of absorber and moderator are given. These values are compared with the f_γ-factors of the ABN-dates. (auth)

9235 AN ANALYTICAL METHOD TO USE THE GENERALIZED HEAVY GAS MODEL FOR REACTOR CELL CALCULATIONS. Kammerer, P. (Univ., Karlsruhe, Ger.). Atomkernenergie, 14: 25-9(Jan.-Feb. 1969).

In the framework of energy dependent diffusion theory and generalized heavy gas model (Horowitz operator) an approximate, analytical expression is derived for the space and energy dependent neutron flux in a reactor cell with optional geometry. (auth)

Experimental Applications

9236 (EURFNR-529) METHOD FOR THE EXPERIMENTAL STUDY OF THE NATURAL FREQUENCIES, NORMAL, AND EXPANSION FUNCTIONS AND THE DAMPING OF TRANSVERSELY OSCILLATING FUEL RODS. Kadlec, J.; Pfrommer, V. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-731. 30p. (EUR-3718). Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

Problems relating to experimental studies on the natural frequencies and the corresponding eigenfunctions of transversely oscillating fuel rods which are supported at several points by spacers are presented. A description is given of the test rig and the results obtained. An electromagnetic exciter system is used in order to achieve the oscillating state in the fuel rod. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 7689, 7888, 7891, 7904, 7908, 7909, 7918, 7919, 7922, 8104, 8106, 8141, 8147, 8172, 8217, 8261, 8273, 8275, 8278, 8279, 8281, 8286, 8287, 8292, 8295, 8297, 8303, 8313–8317, 8341–8343, 8348, 8350, 8356–8358, 8361, and 8363.

9237 (BNWL-907) PLUTONIUM UTILIZATION PROGRAM. Technical Activities Quarterly Report, June-August 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 69p. Dep. CFSTI.

AMERICIUM ISOTOPES Am-241—gamma dose rate measurements on, effects of time on high exposure plutonium oxide (PuO_2) surface
CRITICALITY STUDIES—measurements of critical number of aluminum–plutonium fuel rods in water moderator, effects of lattice pitch and boron concentration on
—measurements of PRCF, effects of boron concentration on
FISSION PRODUCTS—release rate measurements in irradiated plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel rods
GAMMA RADIATION—dose rate from americium-241, effects of time on high exposure plutonium oxide (PuO_2) surface
PHYSICAL CONSTANTS TESTING REACTOR—physics measurements for water-moderated plutonium oxide (PuO_2)–uranium oxide (UO_2) square lattice
PLUTONIUM OXIDES PuO_2—production of americium-241 from high exposure, effects of time on surface
—PuO_2–UO_2, radiation effects on vibrationally compacted fuels of
PLUTONIUM RECYCLE CRITICAL FACILITY—criticality measurements for, effects of boron concentration on
PLUTONIUM RECYCLE TEST REACTOR—control rod worth in Batch Core, measurements of
—fuel element testing in, status of high power density plutonium oxide (PuO_2)–uranium oxide (UO_2)
—Fuel Element Rupture Test Facility of, irradiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2) rods in
—Gamma Scan Facility for, improvements in PNL
—operations during June to August 1968
REACTOR CONTROL ELEMENTS—reactivity worth of PRTR Batch Core, measurement of
REACTOR FUEL ELEMENTS—fission gas pressure measurements in irradiated plutonium oxide (PuO_2)–uranium oxide (UO_2)
—radiation effects on plutonium oxide (PuO_2)–uranium oxide (UO_2), postirradiation examination of
—transient testing of uranium oxide (UO_2) pellet-type and vibrationally compacted, analysis of failures from
REACTOR SAFETY EXPERIMENTS—fuel element transient testing in Transient Reactor Test (TREAT), failure analysis of uranium oxide (UO_2)
URANIUM OXIDES UO_2—fuel elements, transient testing of failures in pellet-type and vibrationally compacted
—PuO_2–UO_2, radiation effects on vibrationally compacted fuels of (D.C.C.)

9238 (CEA-CONF-1078) NONDESTRUCTIVE TESTING OF FLAT FUEL ELEMENTS BY AN INFRARED METHOD. Chretien, N.; Chretien, J. F.; Monnier, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 17p. (In French). (CONF-680606-6). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

Faulty binding or defects on plate fuel elements made up of a uranium core clad by Al sheets can be detected by a thermal method which shows up any parts of the element presenting abnormal heat transfer rates. Local heating is obtained by a light beam from a powerful pressurized Xe lamp focussed on the plate. On the other side of the plate, in line with the heating spot, point measurements of the temperature are made by analysis of the infrared radiation. The radiometer used includes a highly sensitive thermistor bolometer. The advantages of this non-destructive testing method are reviewed. (auth)

9239 (CEA-CONF-1079) TESTING THE HOMOGENEITY OF LAMINATED PLATES BY PHOTOMETRY. Destribats, Marie Therese; Pillet, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Leblanc, Michel (Societe Leanord, Lille (France)). Feb. 13, 1968. 27p. (In French). (CONF-680606-11). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

The apparatus for the automatic inspection of U distribution in laminated plates by photometry of the radiograph is described. The problem of opacity is overcome by radiographing either side of the fuel plate and the entire length, two standards corresponding to the minimum and maximum contents of the tolerance respectively. The opacity of each point on the radiograph is then compared with the opacity of the standards, at points located in the same transverse plane. Advantages of this method and its accuracy are described. (auth)

9240 (EURFNR-530) HIGH-EFFICIENCY HYDRAULICALLY DAMPED SPRING BANK FOR BRAKING AND INTERCEPTING NUCLEAR REACTOR CONTROL RODS. Muehlhaeuser, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translation of report KFK-735. 82p. (EUR-3720). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Damped spring components are required at 2 points in the core of a nuclear reactor: in the safety rod in order to brake the rod inserted in the case of scram shutdown; and underneath the fuel bundles in order to intercept any bundles which become detached, so that neither parts of the core nor the bundle itself is destroyed as they fall under gravity. The spring system developed consists of individual saddle-shaped warped discs, which, in the same way as plate springs, are grouped together in a bank and installed in a housing. The damping is effected by forcing out the liquid between the individual discs and the wall of the housing. The elasticity characteristics were determined theoretically and confirmed by measurements on a plexiglass model. The advantage of this type of spring compared with the others, e.g., helical springs, lies in the simple construction of the damping device, its insensitivity to rupture and its much improved efficiency compared with plate springs. (auth)

9241 (IDO-17280) ACOUST: A DIGITAL PROGRAM FOR ACOUSTIC TRIANGULATION OF NUCLEAR VESSELS. Waite, E. V.; Moore, K. V. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1968. Contract AT(10-1)-205. 19p. Dep. CFSTI.

A structural fault, when deformed, will generate acoustic emissions. Any given acoustic emission can be detected at different times by acoustic sensors located at different positions on the test structure. ACOUST was written to locate the structural fault through the implementation of hyperbolic triangulation on the time-of-arrival differences between a fault and three acoustic sensors. The code is designed to operate on a cylindrical vessel with (or without) capped end sections. The program is written to permit any type of end section geometry, and the program is designed to permit acoustic sensor locations on pipes leading to or from the test vessel. One transducer (per set of three) may be located on a vessel end section. ACOUST is a FORTRAN IV digital computer program written for usage on the IBM 7044. The program occupies 10,343 octal memory locations. Standard input/output assignments are used in the program. The computer usage time required for each solution varies from five seconds to one minute, depending on the complexity of the particular problem. Only the 7044 version of the program is available. An IBM 360-75 version of the code will be available by early 1969. (auth)

9242 (KAPL-3167) LWB/LSBR DEVELOPMENT PROGRAM: IN-PILE MECHANICAL PROPERTIES OF NUCLEAR FUELS. Wisnyi, L. G.; Lovejoy, P. T.; Moyar, G. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 7, 1966. Contract W-31-109-eng-52. 114p. Dep. CFSTI.

Values of viscosity and yield strength are reported for four different nuclear fuel materials tested in reactor environment. These materials are UO_2, 2 wt % UO_2 in ThO_2, 10 wt % UO_2 in ThO_2, and 39 wt % UO_2 in ZrO_2. The tests were conducted at temperatures below 750°C (1328°F) and at fission rates between 4.0 and 7.6×10^{13} fissions/cc-sec in the solid fuel. The experiments consisted of compression tests at a strain rate of 1×10^{-5} in./in./hr and relaxation tests at a constant strain. The data were interpreted by an analysis of the entire system including the cladding, fuel, and loading members. The investigation resulted in a direct measurement of in-pile mechanical properties of nuclear fuel material. The investigation demonstrated that some materials have relatively low fission-induced viscosities, in the order of 10^6 psi-hr, whereas others have viscosities much (decades) greater. At the higher velocities, the yield strength of the material becomes increasingly important. A rheological model of a linear viscoelastic substance with a yield strength is adequate to describe the in-reactor performance of the nuclear fuel materials as tested. 30 references. (auth)

9243 NUCLEAR REACTOR CONTROL ROD WITH GUIDE MEMBERS. Lichtenberger, Harold V. (to Combustion Engineering, Inc.). U. S. Patent 3,407,117. Oct. 22, 1968. Filed Oct. 6, 1965.

A control rod arrangement for a nuclear reactor is described with the rod being comprised of longitudinally arranged tubes bonded together. Interspersed among the tubes is a guide rod for contacting a guide member in the passage in the core of the reactor which is to receive the control rod. (Offic. Gaz.)

9244 NUCLEAR REACTOR FUEL ELEMENTS. Clough, Roy (to United Kingdom Atomic Energy Authority). U. S. Patent 3,407,116. Oct. 22, 1968. Filed Dec. 19, 1966.

For a fast nuclear reactor, a fuel element of the kind having ceramic fuel in metallic sheathing is described, wherein the fuel is divided into inner and outer zones, and an interlayer is interposed between the sheathing and the adjoining surface of the outer

zone, the outer zone having a higher concentration of fissile atoms than the inner zone, and the interlayer being either solely of solid thermal insulating material which does not contain fissile or fertile atoms or alternatively of material which includes fissile atoms. Where fissile atoms of plutonium are included in the fuel, they are preferably segregated exclusively in said outer zone. The zoned arrangement removes some of the heat generation potential from the central region of the fuel element and therefore results in a lowering of center temperature, while the interlayer enables the fuel to be operated so hot as to assume a temperature-induced plasticity and so enable swelling resulting from irradiation to be accommodated internally of the fuel. (Offic. Gaz.)

9245 FUEL ELEMENT-CONTROL ROD ASSEMBLY. North, Donald C. Jr.; Leirvik, Raymond M. (to Babcock and Wilcox Co.). U. S. Patent 3,407,115. Oct. 22, 1968. Filed Nov. 24, 1965.

A fuel element-control rod assembly comprises a bundle of fuel rods extending between and secured to a pair of grid plates, with spacer grids positioned between the grid plates and providing lateral support for the fuel rods. Structural rigidity for the assembly is provided by tie rods disposed about the periphery and in the central portion of the bundle of fuel rods. Four T-shaped control rod channels extend through the assembly about the center tie rod, with each channel being occupied by a control rod. (Offic. Gaz.)

9246 SPACER FOR FUEL ASSEMBLIES. Widell, Bjoern; Van Santen, Aart; Glandin, Constan (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,405,033. Oct. 8, 1968. Priority date July 2, 1965, Sweden.

A nuclear fuel assembly having spacers comprising an outer frame surrounding two rigid grids in spaced relationship to each other and elongate resilient spacer springs supported by and extending between the two grids is described. Each grid comprises a plurality of polygonal meshes and each elongate spring has opposite ends fixed to the grids at the corners of the meshes. (Offic. Gaz.)

9247 IMPROVED SEALING MEANS, PARTICULARLY FOR THE FUEL ELEMENTS OF NUCLEAR REACTORS. Velechovsky, Vaclav (to Skoda, Oborovy Podnik). British Patent 1,135,436. Dec. 4, 1968. Filed Feb. 24, 1966.

A method of sealing the head of a fuel element in its channel of a nuclear reactor, by means of sealing rings similar to piston rings, is described. The grooves are so adapted (e.g., by being T or L shaped in section) that the rings will be retained if they are fractured, and will not foul the channel. (UK)

9248 REACTOR CONTROL ROD DRIVE SYSTEM. Bonnaure, Pierre (to EURATOM). British Patent 1,136,118. Dec. 11, 1968. Priority date Apr. 20, 1965, France.

REACTOR CONTROL ELEMENTS—drives for dual-purpose cable-suspended control and shutdown, description of disengaging lug-drive with electric wound reel (D.C.C.)

9249 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,135,438. Dec. 4, 1968. Priority date Mar. 12, 1965, United States.

REACTOR CONTROL ELEMENTS—description of multiple vertical coolant flow-regulated multiple-ball column-type (D.C.C.)

9250 IMPROVED CONTROL ROD DRIVE. (to Diamond Power Specialty Corp.). British Patent 1,136,877. Dec. 18, 1968. Priority date June 6, 1966, United States.

REACTOR CONTROL ELEMENTS—drives for rod-type, description of dual-gear electric motor-transmission (D.C.C.)

9251 FUEL ELEMENT. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1968-18507. Aug. 8, 1968. Filed Jan. 20, 1965.

The method proposed has the following advantages: easy assembly of fuel element; high accuracy in the assembly; and uniform cooling of the fuel rods. Within the container of fuel rods (constituting a fuel element) are placed horizontal support rings; a wire runs through each series of rings so that the rings move freely, the ends of the wire being fixed at the inner side of the container. Fuel rods are inserted and thus supported among the rings. (NSA of Japan)

9252 SPACERS FOR THE HEAT-INSULATING PLATES OF A REACTOR PRESSURE VESSEL. Matsuda, Naoe (to Hitachi Ltd.). Japanese Patent 1968-19199. Aug. 9, 1968. Filed Dec. 3, 1965.

By the method proposed, the groove work at the point of contact between the partitioning plate and the spacer in the small-radius insulating plates can be performed only by "linear" working. The bending work of spacers at the time of assemblage is thus rendered simple. Spacer plates, with cuts to give tapered parts, are positioned between the insulating plates around the reactor pressure vessel. The top ends of the tapered parts are bent and proper distances are given between the insulating plates. (NSA of Japan)

9253 FUEL ROD. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1968-18508. Aug. 8, 1968. Filed Mar. 12, 1965.

The method proposed has the following advantages: prevention of crumbled sintered fuel; increased capacity of the containment of fission gases; and improved heat removal. It consists of the cladding tube; hollow sintered pellets; a cylindrical pellet support with many holes through the wall and running along the central axis, around which the pellets are inserted; spaces formed both at the top and the bottom of the series of pellets; and hollow rings positioned along the length of the fuel rod, the outside of which contacts the cladding, and the inside, the cylindrical support. (NSA of Japan)

9254 IMPROVEMENTS IN OR RELATING TO THE PREPARATION OF NUCLEAR FUEL ELEMENTS. Redding, Geoffrey Brian (to United Kingdom Atomic Energy Authority). British Patent 1,134,117. Nov. 20, 1968. Filed Apr. 28, 1966.

A method is described of forming a nuclear fuel element incorporating fuel particles which have been adapted to retain fission products by means of an outer coating, and by applying to the outer surface of the particles a further coating comprising a thin layer of thermo-setting synthetic resin by contacting the particles with powdered resin and resin solvent and evaporating the solvent. These particles are disposed in intimate contact with one another and are heated to cure the resin and fix the particles in position. After the particles have been given the resin coating they can, if required, be poured into a blind hole of neutron moderating material and heated in situ to cure the resin and fix the particles in position. The particles can also be subjected to vibro-compacting before heating. (UK)

9255 DEVICE FOR CENTERING IN THE FUEL EXCHANGE. Ebata, Takeo (to Hitachi Ltd.). Japanese Patent 1968-18510. Aug. 8, 1968. Filed Nov. 27, 1964.

By the method proposed, the center of the handling member in fuel loading machine and the center of a fuel channel can be detected accurately and continuously in a simple manner. The top of the cylindrical handling member is in the shape of a convex cone, and the end of a fuel channel is in the shape of a concave cone. Small-diameter holes run through the wall of the handling member. In the fuel exchange, air is flowed through the holes, and the deviation of the two centers with respect to each other is detected by means of the pressure difference. (NSA of Japan)

9256 NUCLEAR REACTOR FUEL ELEMENT. Dunn, Peter Douglas; Whitby, Herbert Clucas; Rice, Graham (to United Kingdom Atomic Energy Authority). U. S. Patent 3,406,090. Oct. 15, 1968. Priority date Dec. 8, 1964, Great Britain.

In a nuclear reactor the fuel elements are porous and a liquid coolant is fed to the element such that the coolant diffuses through the element and leaves the element as a vapor. Preferably the fuel element is a hollow cylindrical body and the coolant diffuses radially through the element. The coolant may be water or a liquid metal and the coolant may be fed to the center of the element to diffuse radially outwards, for example, in a pressure tube arrangement; or the coolant can be supplied as a liquid to the exterior of the element to diffuse radially inwards, i.e., a pressure vessel arrangement. (Offic. Gaz.)

9257 REACTOR MATERIALS. Volume 11, Number 4. Simons, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Winter 1968-1969. 58p. GPO $0.70.

Developments in the evaluation of properties, behavior, and fabrication processes of materials applicable to nuclear reactor components are reviewed. Separate abstracts were prepared for each of the 4 sections: Fuel and Fertile Materials; Moderator and Control Materials; Cladding and Structural Materials; Special Fabrication Techniques. (H.D.R.)

For abstracts of individual sections see: 9262–9265.

9258 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Packman, Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,136,531. Dec. 11, 1968. Filed Jan. 5, 1967.

In fuel pins comprising a stack of cylindrical pellets of nuclear fuel in a cylindrical sheath with a roughened external surface to

enhance heat transfer to the coolant flowing axially over the pin, the problem of ratchetting (axial straining of the sheath due to repeated differential expansion between sheath and fuel) can be alleviated by keying the sheath to the pellets. The keying consists of engaging the sheath wall into circumferential grooves or recesses in some or all the pellets. Hot spots, however, can occur owing to reduced heat transfer in the deformed region. To overcome this, the side of each groove intended to be the first encountered by coolant flowing upwardly and axially relative to the pin should have a shelving taper slower than the opposed side of the groove. (UK)

9259 DEVICE FOR MONITORING VARIATIONS OF A CHARACTERISTIC OF A FLUID IN A MATRIX OF PIPES. Douet, Paul; Roguin, Andre (to Commissariat a l'Energie Atomique). British Patent 1,138,482. Jan. 1, 1969. Priority date Mar. 12, 1965, France.

RADIATION MONITORING—fuel can rupture, description of reactor lattice-arranged coolant-sample-pipes for
REACTOR FUEL ELEMENTS—cladding rupture in cladding of, description of lattice-arranged coolant-sample-pipes with fission product monitors for
REACTORS—fuel can rupture in, description of lattice-arranged multiple coolant-sample-pipes with fission product monitors for (D.C.C.)

9260 MAGAZINE FOR THE STORAGE OF FUEL RODS FOR A NUCLEAR REACTOR. Bouchet, Bernard; Charles, Robert (to EURATOM). British Patent 1,137,758. Dec. 27, 1968. Priority date Aug. 10, 1965, France.

REACTOR FUEL ELEMENTS—storage magazine for, description of coolant-filled cylindrical-shaped radial-arranged telescoping-arm-loaded
REACTOR LOADING MACHINES—fuel element storage magazine for, description of coolant-filled cylindrical-shaped radial-arranged telescoping-arm-loaded
REACTORS—fuel element storage magazine for, description of coolant-filled cylindrical-shaped radial-arranged telescoping-arm-loaded (D.C.C.)

9261 IMPROVEMENTS IN OR RELATING TO PLUG AND SOCKET COUPLINGS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,138,077. Dec. 27, 1968. Priority date Aug. 12, 1965, Germany.

COUPLINGS—description of reactor control element transverse expanding split sleeve plug-and-socket
REACTOR CONTROL ELEMENTS—couplings for, description of transverse expanding split sleeve plug-and-socket (D.C.C.)

9262 FUEL AND FERTILE MATERIALS. Reactor Mater., 11: 205-19(Winter 1968-69).

BERYLLIUM OXIDES—gas release from irradiated, during isothermal annealing
CARBON DIOXIDES—corrosive effects on irradiated uranium
FISSION PRODUCTS—effects of gaseous, on swelling of irradiated reactor fuels
KRYPTON-85—release during oxidation of irradiated uranium by carbon dioxide
LUTETIUM—effects on mechanical properties of alpha-phase uranium alloys
PHOSPHORUS—partial pressure over uranium phosphide (UP)
PLUTONIUM—production and properties for use as reactor fuel, review of
PLUTONIUM ALLOYS—production and properties for use as reactor fuel, review of
PLUTONIUM CARBIDES—production and properties for use as reactor fuel, review of
PLUTONIUM NITRIDES—PuN–UN, radiation effects on swelling of fuel specimens of
PLUTONIUM OXIDES PuO_2—Production and properties for use as reactor fuel, review of
—melting temperature of, effect of oxygen/plutonium ratio on
RADIATION—effects on properties of reactor fuel materials, review of
REACTOR FUELS—swelling of irradiated, effects of fission-gas bubble growth on
—radiation effects on ceramic and metallic, review of
—fabrication of metallic and ceramic, review of
—properties of ceramic and metallic, review of
—corrosion mechanisms of ceramic and metallic, review of
THORIUM—properties for use as reactor fuels, review of
—diffusion in thorium oxide (ThO_2), volume coefficients for
THORIUM OXIDES ThO_2—thorium self-diffusion in, volume coefficients for
THULIUM—effects on mechanical properties of alpha-phase uranium alloys
URANIUM—density of liquid, effects of temperature on
—density of irradiated, effects of high-temperature annealing on
—diffusion in uranium oxide (UO_2), volume coefficients for
—partial pressure over uranium phosphide (UP)
—oxidation by carbon dioxide of irradiated, krypton-85 release during
URANIUM ALLOYS—mechanical properties of alpha-phase, in combination with thulium, lutetium, and yttrium
—Mo–U, radiation effects on swelling of, effects of ternary additions on
—Nb–U–Zr, delayed cracking of gamma-phase, in wet and dry air
URANIUM CARBIDES—solid solubility relations to compound cell dimensions in pseudo-binary systems with uranium arsenide (UAs), uranium nitride (UN), uranium phosphide (UP), and uranium sulfide (US)
—Young modulus of, effect of temperature on
URANIUM NITRIDES UN—Young modulus of, effect of temperature on
—fabrication of reactor fuels of, review of
URANIUM OXIDES UO_2—fabrication and properties of metal-base dispersion reactor fuels of
—uranium self-diffusion in, volume coefficients for
—Young modulus of, effect of temperature on
—oxidation by steam, parabolic-rate-law constants and oxygen diffusion coefficients for
YTTRIUM—effects on mechanical properties of alpha-phase uranium alloys (H.D.R.)

9263 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 11: 220-5(Winter 1968-69).

BERYLLIUM—fabrication of tubes and ingot sheet from
BERYLLIUM ALLOYS—Be–Th, preparation of stable dispersions of
—Be–W, preparation of stable dispersions of
—preparation and properties of wire and rods from
BERYLLIUM OXIDES—rigidity modulus of, temperature and porosity dependence of
BORON CARBIDES—B_4C–Cu, thermal conductivity of dispersions of
BORON ISOTOPES B-10—Al–^{10}B, thermal conductivity of dispersions of
CARBON—creep of glassy, stress and temperature effects on
CESIUM—sorption of liquid, by irradiated graphite
GRAPHITE—defect migration mechanism in irradiated
—sorptive properties of irradiated, for liquid cesium
HAFNIUM—mechanical properties of reactor-grade, effect of annealing on room-temperature
HAFNIUM ALLOYS—Hf–V, phase diagram for
—Cr–Hf, phase diagram for
HYDROGEN—reaction with binary alloys, hydride compositions from
REACTOR MODERATORS—properties of metal hydrides for, review of
—development of, review of
REACTORS—control materials development for, review of
—poison materials development for, review of (H.D.R.)

9264 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 11: 226-52(Winter 1968-69).

AIR—corrosive effects on Type 304L stainless steel at high temperatures
ALUMINUM ALLOYS—corrosion of, crack initiation in stress
—radiation effects on tensile properties of, fast neutron
BEARINGS—materials for steam-lubricated, erosion resistance of
CARBON DIOXIDES—corrosive effects on stainless steel, radiation effects on
CARBON STEEL—corrosion behavior in deoxygenated water
CARBON SYSTEMS—C–NbC, electrical resistivity of, effect of free carbon content and niobium carbide content on
—C–Hf–W, tensile properties of solution-annealed and -aged, high-temperature
—C–NbC, elastic properties of, effect of composition on
—C–NbC–TaC, elastic properties of die-pressed composites of
CERAMIC MATERIALS—strength of oxides, effects of surface treatment on
CHROMIUM—deposition on zirconium for oxidation protection
COBALT ALLOYS—corrosion rate by high temperature refluxing mercury
ELECTRIC CELLS—materials development for thermally regenerative galvanic
HAFNIUM ALLOYS—C–Hf–W, tensile properties of solution-annealed and -aged, high-temperature
HASTELLOY N—ductility of irradiated, effect of strain rate on

HASTELLOY X—ductility of irradiated, effect of strain rate on
HEAT-RESISTING ALLOYS AND METALS—corrosion by gaseous and aqueous media, review of
—cavitation damage in liquid potassium, effect of time and temperature on
—creep-rupture at 1600°C in hydrogen
HYDROGEN—effect on burst strength of cold-worked and annealed Zircaloy-4
—effect on room-temperature uniform elongation of Zircaloy-2
INCOLOY 800—radiation effects on tensile properties of, fast neutron
—ductility of irradiated, effect of strain rate on
IRON ALLOYS—corrosion rate by high temperature refluxing mercury
MAGNESIUM OXIDES—creep of, measurement of high-temperature compressive
MAGNOX ALLOYS—fatigue life of, push-pull tests on cyclic-strain
MERCURY—corrosive effects of high temperature refluxing, on cobalt-base and iron-base alloys
METALS—diffusion in body centered cubic, review of
MOLYBDENUM ALLOYS—properties for use as LMFBR structural materials, review of
NEUTRONS, FAST—effects on reactor structural materials, review of
NIOBIUM—tensile strength of irradiated and unirradiated, correlation of microhardness to
NIOBIUM ALLOYS—Nb-Zr, tensile strength of irradiated and unirradiated, correlation of microhardness to
—properties for use as LMFBR structural materials, review of
NIOBIUM CARBIDES—C-NbC, electrical resistivity of, effect of free carbon content and niobium carbide content on
—C-NbC, elastic properties of, effect of composition on
—C-NbC-TaC, elastic properties of die-pressed composites of
RADIATION—effects on reactor structural materials, review of
RADIOISOTOPES—containment vessel materials for, chemical integrity in rocket launch abort environments of
REACTOR FUEL ELEMENTS—meltdown in water-cooled reactor coolant-loss accidents, metal-water reactions during
—cladding materials for, review of radiation effects in
—cladding materials development for, review of
REACTOR SAFETY—coolant loss accidents in water-cooled reactors, metal-water reactions during
REACTORS—structural materials development for, review of
REACTORS, WATER-COOLED—cooling systems of, corrosion product generation, dispersion, and activation in
—coolant loss accidents in, metal-water reactions during
REFRACTORY MATERIALS—molecular structure of metal carbides, review of
—phase relations of metal carbides, review of
—processing of, effects of hot-pressing conditions on
—properties of, review of physical and mechanical
—hot hardness of various borides, carbides, and oxides
SELENIUM—effect on room-temperature uniform elongation of Zircaloy-2
SILICON—effect on tensile properties of vanadium
SODIUM—corrosive effects on reactor fuel cladding and structural materials, review of
SODIUM ALLOYS—K-Na, corrosive effects on reactor fuel cladding and structural materials
STAINLESS STEEL—oxidation of Type 304L, by high temperature air and steam
—oxidation by carbon dioxide, radiation effects on
—oxidation of austenitic, dimensional increase from
—corrosion behavior of Type 304, in deoxygenated water
—corrosion product generation, dispersion, and activation in water-cooled reactors
—rupture life of Type 304 tubes, effect of thermal cycling in flowing liquid sodium on
—radiation effects on tensile properties of Type 304, Type 316L, and Type 347, fast neutron
—radiation effects on burst strength, ductility, and void formation in Type 304, fast neutron
—stress-rupture properties of irradiated Type 316, effect of preirradiation annealing on
—ductility of irradiated Type 316, effect of preirradiation annealing temperature on
—creep properties of Type 304L, effect of prestrain and irradiation on
—ductility of irradiated, effect of strain rate on
STEEL—radiation effects on room-temperature tensile properties of pressure-vessel, fast neutron
TANTALUM ALLOYS—oxidation protection by electrophoretic coating systems
—properties for use as LMFBR structural materials, review of
TANTALUM CARBIDES—C-NbC-TaC, elastic properties of die-pressed composites of
TITANIUM—hydriding in low temperature aqueous solutions
TUNGSTEN ALLOYS—properties for use as LMFBR structural materials, review of
—C-Hf-W, tensile properties of solution-annealed and -aged, high-temperature
TURBINE BLADES—materials for gas, corrosion resistance of
VANADIUM—tensile properties of, effect of silicon content on
VANADIUM ALLOYS—properties for use as LMFBR structural materials, review of
ZIRCALOY-2—oxidation kinetics in subatmospheric oxygen and water
—corrosion by water, effect of surface condition on
—hydriding in low temperature aqueous solutions
—elongation of, effect of selenium and hydrogen on room-temperature uniform
ZIRCALOY-4—oxidation by steam, kinetics of high-temperature
—burst strength of cold-worked and annealed, effect of hydrogen content on
ZIRCONIUM—oxidation protection by thin chromium coatings
—oxide films on, characteristics of electronic conduction sites on
—corrosion by organic reactor coolants
ZIRCONIUM ALLOYS—radiation effects on creep of (H.D.R.)

9265 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 11: 253-61(Winter 1968-69).

CERAMIC MATERIALS—fabrication techniques for, review of
CERMETS—fabrication techniques for, review of
HEAT-RESISTING ALLOYS AND METALS—fabrication techniques for, review of
—bonding of, parameter of gas-pressure solid-phase
—plating of, review of chemical-vapor-deposition and electrodeposition processes for
—welding techniques for, review of
MATERIALS TESTING, NONDESTRUCTIVE—techniques development for reactor materials, review of
REACTOR FUEL ELEMENTS—cladding materials for, review of fabrication techniques for
REACTOR FUELS—fabrication techniques for, review of
REACTORS—structural materials for, review of fabrication techniques for
REFRACTORY MATERIALS—fabrication techniques for, review of
STAINLESS STEEL—welding techniques for, review of
ULTRASONIC INSPECTION—techniques development for reactor materials, review of (H.D.R.)

9266 NUCLEAR REACTOR FUEL ELEMENTS. Swanson, Kenneth MacGregor (to United Kingdom Atomic Energy Authority). U. S. Patent 3,414,474. Dec. 3, 1968. Priority date Aug. 8, 1966, Great Britain.

A fast nuclear reactor fuel element has sheathing forming an external and an internal wall, both exposed to the same flowing coolant, ceramic nuclear fuel contained in the sheathing and having a density less than maximum theoretical so as to provide distributed voidage in the fuel, the fuel closely contacting the inner face of the internal wall while a growth-accommodating gap exists between the fuel and the inner face of the external wall, the gap serving to insulate the fuel from the external wall so that its operating temperature is raised compared with that of the fuel contacting the internal wall which thus lowers the compressive creep resistance of the fuel and induces irradiation-induced swelling to be absorbed in the distributed voidage of the fuel. The gap can have crinkled foil of a refractory metal within it to partially support the fuel, and the external sheathing wall can constitute a shell containing coolant tubes forming the sheathing internal wall and on which columns of hollow fuel pellets can be stacked. (Offic. Gaz.)

9267 NUCLEAR REACTOR FUEL BUNDLE. Lass, J. L.; Venier, D. A. (to General Electric Co.). Canadian Patent 794,999. Sept. 17, 1968.

The nuclear characteristics of this fuel bundle may be readily altered within wide limits at the reactor site to accommodate the deviations from those reactor characteristics which were assumed would exist when the fuel was designed. One or more easily removable special neutron absorber rods within the bundle is the important feature. Reactor control is enhanced because the reactivity of the fuel bundle can be adjusted along with the usual control rod manipulation. (F.S.A.)

GENERAL

9268 (AE-338) CALIBRATION EXPERIMENTS WITH A DISA HOT-WIRE ANEMOMETER. Kjellstroem, Bjoern; Hedberg, Stellan (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1968. 111p. Dep.

The relation was studied between the voltage over the wire of a hot-wire anemometer, the velocity and the angle of incidence of the flow in local turbulent transport. In order to check these calibration experiments, shear stress and turbulence measurements were made in a circular channel. For this geometry the shear stress distribution can be estimated theoretically and several earlier experiments can be used for comparisons. These experiments were made at Reynolds numbers 3×10^5 to 10^6, Mach numbers 0.1 – 0.3 and a channel length of 61 diameters. Good agreement was obtained with the theoretical shear stress distribution – corrected for compressibility effects — and earlier data for the axial and radial turbulence components when the results of the calibration experiments were used for the evaluation of these measurements. Evaluation with a constant value of c with k^2 equal to zero gave worse agreement. (Swed)

9269 (AEC-tr-6869/3) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: 353-525(1967). 172p. (TT-67-51421/3; IPST-Cat.-5063). CFSTI.

Abstracts of 6 of the main articles and 8 of the Brief Notes from the original Russian issue of this journal appeared in NSA Vol. 21, No. 18. (TSS)

9270 (AEC-tr-6869/6) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: 881-1049(June 1967). 172p. (TT-67-51421/6; IPST-Cat.-5066). Dep. CFSTI.

Abstracts of 9 of the main articles from the original Russian issue of this journal appeared in NSA Vol. 21, No. 19. One of the Brief Notes, "Nanosecond Generator of Neutron Pulses" was abstracted from the original Russian and appears in NSA 21: 44526. (TSS)

9271 (AED-AB-1968-11) INFORMATION ON NUCLEAR SCIENCE AND TECHNOLOGY. Abstract Journal. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Nov. 1968. 241p. (In German and English).

Topics include biology and medicine, chemistry, geology and space research, isotope technology, radiation protection, instrumentation, materials, physics, and reactor physics and technology. Conference number, conference location, and conference date indexes are presented. Also, author, report number, and subject indexes are included. (W.H.K.)

9272 (BMI-171-013) DEMOGRAPHIC CHARACTERISTICS OF HUMAN GROUPS INHABITING THE EASTERN REGION OF THE REPUBLIC OF PANAMA. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. de Arauz, Reina Torres (Battelle Memorial Inst., Columbus, Ohio). Feb. 23, 1968. Contract AT(26-1)-171. 24p. Dep. CFSTI.

Being in possession of gross rate of reproduction estimates for each zone, demographic growth rates were calculated for each zone. The results showed that by virtue of the lowest mortality rate, the Negro group of the eastern region demonstrates the fastest demographic growth, with an increased rate of 32 per one thousand inhabitants. At this rate of growth, a population is doubled in about 20 years. In accordance with the estimated rates, the Cuna Indians register the lowest rate of growth due to the very high levels of mortality. (E.R.B.)

9273 (BNL-13063) REACTION OF HCl WITH LIQUID SODIUM AND A SODIUM-BARIUM ALLOY. Hobdell, M. R.; Newman, L. (Brookhaven National Lab., Upton, N. Y.). Nov. 1, 1968. 34p. (CONF-681106-4). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

The reaction of HCl with pure sodium and sodium containing dissolved barium is described. In both cases the reaction took place in two separate steps: $HCl \rightarrow \frac{1}{2}H_2 + Cl^-$ and $\frac{1}{2}H_2 \rightarrow H^-$. The effect of barium was to decrease the rate of hydrogen production, while increasing that of hydrogen uptake. The formation of molecular hydrogen was controlled by processes of a physical nature. The rate-determining step for hydrogen absorption, however, apparently involved the adsorption and dissociation of hydrogen molecules at the metal surface. (auth)

9274 (BNL-50106) ANNUAL REPORT, JULY 1, 1968. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. 225p. Dep. CFSTI.

The program and activities of Brookhaven National Laboratory during the fiscal year 1968 are discussed. Topics include physics, high-energy accelerators, instrumentation, chemistry, nuclear engineering, applied mathematics, biology, medical research, technical operations and services. (B.G.D.)

9275 (CTC-6) EXPERIENCE WITH PIVOT SELECTION METHODS FOR THE GOMORY ALL-INTEGER PROGRAMMING ALGORITHM. Copper, J. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Dec. 16, 1968. Contract W-7405-eng-26. 16p. Dep. CFSTI.

The results of a study involving pivot selection methods are reported. The study involves testing 19 proposed problems with 7 pivot selection methods. The objects of the study are to identify the method that is the fastest and most reliable on the particular problem set, and to identify the attributes of the problems that make them readily solvable by a particular method. (auth)

9276 (EGG-1183-444) R-F CONTROLLER, TYPE CC-372. Number B-3753. Mee, James (EG and G, Inc., Boston, Mass. Eastern Science and Technology Div.). Mar. 4, 1968. Contract AT(29-1)-1183. 15p. Dep. CFSTI.

An improved fail-safe system for rf oscillator sources is described. The unit samples the rf output of the master oscillator and switches to the slave oscillator whenever the output of the master oscillator falls below a preset minimum level. (W.H.K.)

9277 (EUR-4064) MODIFIED ELECTRON SPIN RESONANCE SPECTRUM SIMULATION PROGRAM. An IBM 360/65 Modified Version of the L. C. Snyder's Program for the Computer Simulation of the Electron Spin Resonance Spectra of Aromatic Ions and Radicals. (Bell Telephone Lab.). Inzaghi, A.; Mongini, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1968. 40p. Dep.

The report describes an IBM 360/65 modified version of the Electron Spin Resonance Spectrum Simulation Program written by Lawrence C. Snyder for computer simulation of E.S.R. spectra of aromatic ions and radicals. CALCOMP spectrum plotting has been added to directly compare theoretical and experimental spectra. The possibility of hyperfine structure due to nuclei with spin 1 and $\frac{3}{2}$ has been included. (auth)

9278 (GEPP-48) THE EXTENDED RANGE GAP (ERG). Howell, J. F. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Oct. 9, 1968. Contract AT(29-2)-656. 9p. Dep. CFSTI.

The Extended Range Gap (ERG) is a cold cathode switching device that has the capability of switching up to several thousand amperes, with extremely low time jitter and delay, over an operating range of <300 to 30,000 volts. The performance characteristics of the ERG device and its circuitry are discussed. (auth)

9279 (JUL-Bibl.-12/2) CANCER CHEMOTHERAPEUTICS (CYTOSTATIC EXCLUDING HORMONES AND RADIONUCLIDES). Literature Review II (1957-1967). Paul, Rolf (Kernforschungsanlage, Juelich (West Germany)). Mar. 1968. 521p. (In German and English). Dep.

A bibliography of 3,766 titles is presented of works on cancer chemotherapeutics. The majority of the references are from 1966 and 1967 but works dating back to 1957 are also included. (J.S.R.)

9280 (K-1736(Rev.)) USER'S MANUAL: UCARDS, UNION CARBIDE AUTOMATIC ROUTING AND DESIGN SYSTEM FOR PRINTED CIRCUIT BOARDS. Jamison, J. F. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Dec. 13, 1968. Contract W-7405-eng-26. 94p. Dep. CFSTI.

UCARDS is a computer aided design system for producing component layout, conductor layout, and other aids to the fabrication of printed circuit boards. This manual is intended to serve as a guide to the proper use of the system, and supersedes report K-1736. (auth)

9281 (K-1768) REPORT ON THE VESTIBULE CLERICAL TRAINING PROGRAM CONDUCTED BY UCC NUCLEAR DIVISION. Friar, Lorene (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 27, 1968. Contract W-7405-eng-26. 59p. Dep. CFSTI.

The pilot vestibule clerical training program from its inception to conclusion and placement of the trainees is described. The selection criteria, purpose and objectives, and test evaluations are outlined. (auth)

9282 (LA-3996) VEBLEN-WEDDERBURN SYSTEMS. Everett, C. J. (Los Alamos Scientific Lab., N. Mex.). Aug. 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

It is shown that Veblen-Wedderburn systems of order $N = p^n$, not division rings, exist for every $p \geq 2$, $n \geq 2$, for p an odd prime,

and for p = 2, n composite. The proof suggests a matrix algorithm for constructing all V–W systems. The method is carried through for p = 3, n = 2 and reveals 5 such nonisomorphic systems. Some orienting remarks of an expository nature are included as an introduction to these structures and to their relation to the combinatorial configurations known as finite planes. (auth)

9283 (LA–4020) RDTRAN: A PROBLEM-ORIENTED LANGUAGE INPUT PROCESSOR. Brazier, Emmett L. Jr.; Griffin, James H. (Los Alamos Scientific Lab., N. Mex.). Aug. 1968. Contract W-7405-eng-36. 99p. Dep. CFSTI.

RDTRAN is a computer program for translating and processing free-format input data. It is an interpretive system designed for use as the input translator of a problem-oriented source language, or as a general purpose free-format input loader. RDTRAN is written in USA Standards Institute (USASI) FORTRAN for easy compatibility with a variety of computer systems, and also serves as an experiment in the effectiveness of USASI FORTRAN as a machine-independent language. A source language listing of the RDTRAN program is presented, and the IBM-7094 machine-dependent subroutines are included. Machine-dependent modifications for the CDC-6600 will be issued as a supplement. A reference guide, systems manual, and detail flowchart will be issued as companion reports. (auth)

9284 (NP–17715) NUCLEAR SCIENCE IN MAINLAND CHINA. A Selected Bibliography. Wang, Chi (Library of Congress, Washington, D. C. Science and Technology Div.). 1968. 70p. GPO $0.70.

A compilation of 615 titles of research reports, studies, articles and other informative materials on nuclear science in mainland China is presented. Publications in the Chinese language published between 1958 and 1966 are listed under the topics of bibliographies and dictionaries, general works, biology and medicine, chemistry, geology, geophysics, and mineralogy, physics, thermonuclear processes, metallurgy and rare earth metals, particle accelerators, reactors and reactor technology, isotope technology, radiation detectors and nuclear instruments, radioactive waste process and treatment, and nuclear weapons and warfare. Publications in other languages between 1964 and 1967 are included under the topics of bibliographies and dictionaries, science and technology, research and facilities, manpower and education, strategy and policies, weapons development and military potential, weapons control and defense measures, and nuclear tests. Author and subject indexes are included. (W.H.K.)

9285 (NYO–3748–9) COMPUTER PATTERN RECOGNITION: DEVELOPMENT OF AN AUTOMATED HUMAN CHROMOSOME ANALYSIS SYSTEM. Interim Progress Report. Neurath, Peter W. (New England Medical Center Hospitals, Boston, Mass.). Apr. 15, 1968. Contract AT(30-1)-3748. 26p. Dep. CFSTI.

A pre-processing algorithm for human chromosome analysis was developed, refined, and tested. Stepwise discriminant analysis programs gave moderately good chromosome classifications with only arm lengths measurements. The quality of chromosome spreads was substantially improved and actual experience in computer-aided chromosome analyses was being obtained. Speed, accuracy, cost, and usefulness of the technique are being determined. (E.R.B.)

9286 (ORNL–4321) ALTERNATIVE EFFECTS OF GENERATIONS AND AGING UPON POLITICAL BEHAVIOR: A COHORT ANALYSIS OF AMERICAN ATTITUDES TOWARD FOREIGN POLICY, 1946–1966. Cutler, Neal E. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 440p. Dep. CFSTI.

9287 (ORNL–4349) LINEAR PROGRAMMING MODEL FOR FOREST PRODUCTION CONTROL AT THE AEC OAK RIDGE RESERVATION. Norman, E. L.; Curlin, J. W. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 48p. Dep. CFSTI.

A mathematical model is presented which annually optimizes the cutting schedule in two arbitrarily selected compartments on the Oak Ridge Reservation. Yield equations were developed for three major timber types of that area. A comparative site index study was undertaken so that a measure of site quality could be used as an independent variable in the yield equations. The objective function was maximized over one cutting period, i.e., a period of twelve years. Over this period, selected management alternatives were proposed and evaluated subject to various management restrictions. The model selects for cutting those alternatives which maximize the value of the residual stand discounted to the present. The limitations and utility of the model are discussed. The manner in which information from this model can aid the forester in maximizing forest income is shown. (auth)

9288 (PAEC(A)IN–631(Suppl.3)) NUCLEAR ENERGY IN THE PHILIPPINES. An Annotated Bibliography. (Philippine Atomic Energy Commission, Manila). Mar. 1968. 22p. Dep.

Abstracts of fifty-seven articles on research by scientists of the Philippine AEC are included. The abstracts are categorized by subject, and an author index is included. (C.E.S.)

9289 (RISO–M–812) DESCRIPTION OF AEK PROGRAMME NO. 513, EXPOSUM. Kirkegaard, Peter (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1968. 14p. Dep.

A computer program, AEK P-513 EXPOSUM, is described. The problem solved is a fitting of the constants in a sum of exponentials to given table values. EXPOSUM is written in GIER-ALGOL III. (auth)

9290 (TID–4577(Rev.3)) DESCRIPTIVE CATALOGING GUIDE. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Dec. 1968. 84p. Dep. CFSTI.

A guide for descriptive cataloging for the AEC Division of Technical Information Extension for bibliographic control of nuclear science literature prepared for NSA is presented. Discussed are preparation of cataloging form and draft tape, preparation of reproduction copy and computer input tapes, program tapes, cataloging elements, and examples for each type of item descriptively cataloged, and composition rules and other details. (W.H.K.)

9291 (UCRL-50517) THE DIFFUSION OF SILICON IN α–Fe AND α–Fe–Si ALLOYS. Lai, D. Y. F.; Borg, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 3, 1968. 9p. Dep. CFSTI.

The diffusion coefficients of silicon in α–Fe and dilute Fe–Si alloys were determined as a function of temperature and composition. It was found that Fe–1.8V may be used in place of Fe to maintain the bcc structure over the entire temperature region, the activation energy is essentially independent of composition (up to 4.7% Si), and the diffusivity varies logarithmically with composition, probably only because of the variation in the correlation coefficient. (auth)

9292 (UCRL-Trans-10307) PREPARATION AND SPECTRAL PROPERTIES OF EUROPIUM TRIS-(5-NITRONAPHTHALENE-1-SULFONATE). Loriers, J.; Heindl, R. Translated by W. E. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Compt. Rend., 259: 4571-4(1964). 8p. Dep. CFSTI.

The europium salt of 5-nitronaphthalene-1-sulfonic acid is readily obtainable by precipitation from aqueous solutions of europium chloride and the organic acid. The resulting compound is very soluble in dimethylformamide. It has a wide absorption spectrum, extending from 3000 to about 4300 Å. When exposed to uv-rich radiation it gives a fluorescence emission spectrum characterized by two groups of intense lines centered about 6135 and 5930 Å. The intensity of the second group of lines distinguishes this compound from the europium chelates studied by other workers. (auth)

9293 (WASH–1123) ATLAS OF THE DOMESTIC TURKEY (MELEAGRIS GALLOPAVO). MYOLOGY AND OSTEOLOGY. Harvey, E. B. (Division of Biology and Medicine (AEC), Washington, D. C.); Kaiser, H. E. (George Washington Univ., Washington, D. C. Dept. of Anatomy); Rosenberg, L. E. (California Univ., Davis. Dept. of Zoology). [nd]. 255p. Dep. CFSTI.

Fifty-eight plates of detailed drawings of the muscles of the turkey are included. Accompanying each plate there is a description of the form, relationships, origin, insertion, and action of each muscle. There are 27 plates of drawings of the bones accompanied by descriptions of the form and relationships of each. Each drawing is fully and accurately labeled. A page and plate number index to the muscles and bones and a bibliography of 44 references are included. (H.L.W.)